THURSDAY, JULY 4, 1895.

## THE MOLUCCAS.

*Reisen in den Molukken, in Ambon, den Uliassern, Seran (Ceram) und Buru. Eine Schilderung von Land und Leuten.* Von K. Martin. Large 8vo. Pp. xviii. and 404, and volume of plates. (Leyden: E. J. Brill, 1894.)

THE Moluccas, the spice islands of the farthest east, were the most powerful magnets which drew the fleets of Portugal eastward around the Cape of Good Hope in the fifteenth century, and in the sixteenth induced Magellan to start on that voyage through his straits which culminated in the first circumnavigation of the globe. They were the most coveted lands on earth at the commencement of the history of modern discovery, the most eagerly sought for, first acquired, and the most firmly held of the colonies of Europe. Yet while the group has changed hands again and again without passing out of European ownership, the islands are still most imperfectly known. The system of exclusion which animated Portuguese, Spaniards, and Dutchmen alike, discouraged systematic exploration; and the works of such travellers as have recently made explorations in the islands, are for the most part locked up from the general reader in the Dutch language. In English, indeed, there is the matchless work of Wallace; but this, like several later English books on the Malay archipelago, is mainly concerned with the study of biological conditions.

Dr. Martin, the Professor of Geology in the University of Leyden, already well known for his admirable work on the Dutch West Indies, obtained a grant from his Government in 1891, and with a year's leave of absence proceeded to the study of some of the more interesting and less known islands of the Malay archipelago. Leaving Batavia on November 3, 1891, he coasted along Java, touched at Bali, visited various points on Celebes and Jilolo, making such geological and general observations as were possible in the limited time at his disposal. On November 27 he reached Amboyna, and until July 27, 1892, he devoted his whole time to detailed exploration, determining positions and heights, photographing scenery, people and houses, and collecting everything that came in his way in the islands of Amboyna, the Uliasser, Buru, and Ceram. In this way many places were visited which had never been adequately described before, several districts which had never been traversed by Europeans, and some which even the natives had avoided as sacred or unclean. The book is mainly geographical, going so far into the structure and vegetation of the land as is necessary in order to understand the life-conditions of the inhabitants, on whom also great attention is bestowed. Detailed reports on the geology, botany, the birds, insects, and other collections are being prepared by Prof. Martin and other specialists; but here he confines himself to the narrative of his expedition, with numerous explanations suggested by the preliminary results.

We so often find that books of travel are flabby masses of ill-upholstered padding, put together at second-hand by some big-game hunter or globe-trotter after his return, that we feel it a duty to call attention to the admirable form and substance of this one. It is of the order of Darwin's, Wallace's, and Bates' work, and though based on shorter experience than theirs, is none the less scientifically put together.

Prof. Martin says in his preface, that he gives a pure record of actual observations taken directly from his note-books and collections. After writing it, he proceeded to read up all the available literature on the subject, and took occasion in a series of footnotes to explain discrepancies or criticise his predecessors. In many respects this is an excellent method to pursue. The mind is free from prejudice or anticipation, and the observations bring the charm, and leave the stimulus of discoveries. On the other hand, unless what is known is previously worked up, there is apt to be much loss of time which could be more profitably spent, and points of the highest interest, being unsuspected, may pass unnoticed. We are inclined to believe, however, that, in spite of his modest disclaimer, Prof. Martin had a very good notion of what had been done before he entered the field. Otherwise he could scarcely have been so self-denying as to turn away from the people of Amboyna and the Uliasser, who have been fully studied by van Hoëvell, Joest, Riedel, and others, and give attention mainly to the features of the land. And in Ceram he knew very well where the coast-lines were faultiest on the maps, and the mountains and rivers scattered according to the freest fancy of the cartographer; for there he proceeded to fix positions and draw maps, while giving attention at the same time to general collecting and to the study of the people and their customs.

In view of the distrust which has gradually beset the aneroid when used for measuring heights, it is interesting to learn that the result of Dr. L. S. Siertsema's discussion of the numerous aneroid readings made on this journey is to show that it is, after all, an instrument of considerable precision for elevations well under 10,000 feet.

The book is to be welcomed as the thoroughly sound work of an experienced man of science, and as containing a notable contribution to our scanty knowledge of a most fascinating region, and of primitive peoples whose ancient customs are fast giving way before the pervading European influence. It suggests forcibly the importance of the study of regional geography in those places where the natural equilibrium of life and physical environment has not been disturbed; such places as are now scarcely to be found. It is exasperating to think that the careless traders and earnest missionaries who haunt the islands of the sea are every day rejecting sybilline books, the value of which seems likely to remain unsuspected, save to a handful of anthropologists, until the last of them is destroyed beyond recovery. The facts that primitive man must be studied at once if he is to be studied at all, and that purely natural floras and faunas are doomed to early disappearance from this planet, call for more workers like Prof. Martin, and demand them soon. The demand is for educated scientific explorers such as there is at present no means for training in this country. The day when geographical work of the first magnitude can be done by mere pluck and perseverance is almost past, and

the explorer of to-day must add to his enterprise scientific training, and to scientific training diligent study.

The contrast between the means of training for explorers in this country and on the continent, suggests many curious thoughts as to the proportion in which different countries will undertake the detailed study of the earth's surface in all its aspects, from which alone a true view of nature can be obtained. The theoretical training in geography only to be obtained in continental universities, and the practical training in the use of instruments and methods offered only by the Royal Geographical Society, are too far apart, and until they come together the general level of original work in unexplored countries will fall far short of the standard set by Prof. Martin. HUGH ROBERT MILL.

## MILL ENGINEERING.

*Steam Power and Mill Work.* By George William Sutcliffe, M.Inst.C.E. (London: Whittaker and Co., 1895.)

THE Specialist Series of technical books is well known and appreciated; many subjects are admirably treated by well-known authors. The present volume, of some 800 pages, is no exception to this rule, and it fully maintains the high character of the series. In the preface we are told that this work aims at giving an account of modern practice for the consideration of those interested in the manufacture, control, and operation of boilers, engines, and mill work, also of the leading principles and calculations affecting such work, most of the subject-matter being based upon the personal experience of the author. Useful information has also been obtained from the minutes of proceedings of the leading technical societies and from various journals, adding considerably to the value of the book. Taken as a whole, this work will be of much use to steam users, particularly those employing steam power extensively with much machinery in operation.

It is impossible to notice in the space at our disposal the large amount of ground covered in this book. The author has arranged his matter in a sensible manner, and explains himself in a practical way. Many steam users are under the erroneous impression that the economical firing of a boiler is easily accomplished, that any labourer is capable of handling the shovel; to such men we recommend a careful perusal of this work, wherein they will discover that economical firing means more than they anticipated.

The author has much to say in chapter vi. on convection, circulation, evaporation, and priming in boilers. These points are thoroughly well discussed, being all-important to the life of the boiler and the comfort of the user. The estimation of the moisture in steam as delivered from the boiler is often necessary, and the difficulty of obtaining a true sample of the steam has to be met. Much useful information is given on this subject, and we would draw the attention of the author to an instrument designed by Prof. Watkinson, of Glasgow, which appears to give true results for the direct estimation of small quantities of water in steam.

The different methods of forced draught are discussed in the following chapter. The author, when describing the closed stoke-hole system, observes: "It is scarcely possible to imagine a case in which it would be wise to adopt a closed stoke-hole in stationary work." This is a very usual opinion held by engineers, who believe that most of the break-downs in the Navy, through leaky tubes, may be traced to this system of forced draught being adopted. The question of gas firing appears to be coming to the front for steam boilers in towns, for the prevention of smoke, and an increased economy in fuel. There is no doubt that a good deal can be said in favour of the system. The author has much useful information on the subject, particularly on the production of gas for the purpose. Liquid fuel, again, is another innovation in the way of raising steam. This system has reached its present state of perfection in the hands of Mr. Holden, the locomotive engineer of the Great Eastern Railway, who has successfully applied it to locomotives and stationary boilers.

The important subject of a pure water supply for steam boilers is pointed out in the following chapter. The effects of different impurities are described, besides the dangerous results involved by admitting grease into a boiler with the feed-water through contamination with the exhaust steam. Many furnaces have collapsed from this cause. We now come to the more mechanical part of the book, commencing with the construction and general fittings of Lancashire and Cornish boilers. Taken as a whole, the subject of boilers generally is fairly well dealt with. In the paragraph on internal flues, we find no description of Fox's corrugated flues, nor those of the Farnley Company; both are very commonly in use, and should have been mentioned. Under the head of "riveting" it might be well to point out that, although steel rivets are now the general rule when closed by machine, the few hand rivets necessary should in all cases be of Yorkshire iron. Caulking is now generally done by steam or pneumatic tools, the best of which is certainly Macewan Ross's patent, of Glasgow. Probably the most important fitting for a boiler is the glass-water gauge, and this should close automatically if the glass breaks. There are many of these in the market, more or less trustworthy; those supplied by Messrs. Dewrance and Co. being among the best. The author recommends the pendant syphon arrangement for fixing the pressure gauge to the boiler. This allows too much heat to reach the gauge through the heavy metallic fitting, and cannot be recommended for this reason. The locomotive type of stationary boiler is being largely used for steam raising; it is economical, easily set in position, and produces large quantities of steam when pressed.

Under the heading of "Types of Steam Engines," we find much information of a varied nature. The Willans central valve engine is, however, not described. This is a pity, because it is now being largely used for ordinary work, and gives great satisfaction. It is most economical, and will run for months without attention. The author goes into much detail when discussing valve arrangements for steam engines, commencing with the well-known "technical school" diagrams of slide valves with and without lap, &c., and ending with the piston valve; then follows double beat valves, Corlin valves, and many others. All these descriptions are clear and to the point.

Chapters xxiv. to xxxiv. may be said to contain descriptions of the construction and design of the principal parts of steam engines. Some formulæ are given, as well as a few maximum pressures allowable on the different parts. On page 428, the author says that the pressure of 80 lbs. per square inch of bearing surface is allowed in locomotive practice between the slide blocks and bars, *when both surfaces are of hardened steel*. It is not the usual practice to make the slide block surfaces of hardened steel, and in engines built years ago, the pressure per square inch very much exceeded this limit. In most recent practice with cast-iron bars and slide blocks, this limit may be safely used. The taking of indicator diagrams is always one of interest. Chapter xxv. deals very thoroughly with this subject. Trials in connection with the power and efficiency of engines and boilers naturally follow the indicator, and very complete instructions are given for carrying these out, including precautions in advance of the trial. The concluding chapters of this work deal principally with mill work in its many branches. Friction and lubrication are explained, and many valuable hints are given. This book should prove of assistance to the steam user. The information given is of such a nature which will appeal to his partial knowledge of the subject, and render him more capable of understanding machinery generally.

N. J. L.

## *LECTURES ON DARWINISM.*

*Lectures on the Darwinian Theory.* Delivered by the late Arthur Milnes Marshall, M.A., M.D., D.Sc., F.R.S., Edited by C. F. Marshall, M.B., B.Sc., F.R.C.S. (London: David Nutt, 1894.)

ALL the characteristics of the late Prof. Milnes Marshall are strikingly apparent in these lectures. In dealing with the many aspects of a subject which is often imperfectly understood, these lectures are clear and forcible, and the metaphors apt and convincing.

The first lecture deals with the history of the theory of evolution, and contains a concise and interesting epitome of the growth of this great conception, together with a brief account of the chief writers on the subject. The relationship between the process of evolution and the causes upon which it depends are perhaps liable to misinterpretation, the want of any feasible suggestion as to the latter being spoken of as a "fatal flaw" in, or a "fatal objection" to the former. Undoubtedly the want of some efficient cause at first prevented a wide belief in evolution, but logically the two questions are entirely distinct, and the evidence for evolution itself would stand undisputed, even if every one of the causes which now find acceptance were to be abandoned for ever. We know that Darwin himself was a convinced evolutionist long before his discovery of the principle of natural selection.

The second lecture treats of artificial and natural selection, and is accompanied by useful figures showing some of the changes which man has been able to accomplish in the creation of his domestic breeds. The whole lecture is clear and telling, the last paragraph being alone liable to possible misconception. In stating that "every species is for itself and for itself alone," it would have been advisable to bring forward instances in which a species benefits itself by benefiting others. It is most probable that such cases were described in the actual delivery of the lecture.

Then follow the arguments in favour of evolution, palæontology being first considered. We here meet, as in many of the other lectures, with exceedingly apt quotations from Darwin, Wallace, and others. It is an unfortunate omission that references are not given. In the delivery of the lectures to a general audience they may have been out of place, but there could have been no difficulty in their insertion in the present volume. Here, too, we find many useful figures of some of the extinct forms which are of the highest interest to the student of evolution. The reasons for the imperfection of the geological record are very excellently, and yet briefly, surveyed; and the same may be said of the sketch of the argument from geographical distribution, in which, however, by an obvious slip, the forest region of Brazil is spoken of as "south of the river La Plata" (p. 75).

The argument from embryology was probably the most congenial to the lecturer. This chapter is well illustrated, and contains more detail than the others. The term "acquired or larval characters" (p. 103) is open to exception, and the statement that rudimentary organs must be "inherited, for in no other way can their presence be explained" (*loc. cit.*), is too brief to be clear. It is probable that this sentence served as a note to be expanded by the lecturer; but it also required expansion by the editor. The chapter will be found extremely interesting and instructive by those who wish to read a popular account of the bearing of embryological facts upon the Darwinian theory.

The chapter on the colours of animals and plants, although containing much information in a little space, is not worked out in so complete and balanced a form as the other chapters, and in large part consists, apparently, of notes for the lecturer's use. It is erroneously stated that the colours of certain lepidopterous larvæ are due to their food, and some of the supposed examples of the direct action of environment are by no means proved to be caused in this way.

Then follows an interesting lecture on the "objections to the Darwinian theory." The figures of Pteropus on p. 165, although sufficient in themselves, are clumsily arranged. Here, too, many aspects of the subject are only treated in brief· lecturer's notes, although these frequently contain trenchant remarks.

The "origin of vertebrated animals" is next considered, and the series concludes with an excellent epitome of "the life and work of Darwin."

It will be seen that the sequence of subjects is a very natural one, and well calculated to lead a general audience to follow and understand the most prominent and important aspects of the Darwinian theory.

E. B. P.

## *OUR BOOK SHELF.*

*My Climbs in the Alps and Caucasus.* By A. F. Mummery. Illustrated. (London: T. Fisher Unwin, 1895.)

MR. MUMMERY is a bold man. Not only has he dared greatly among peaks and glaciers, but also he does not scruple to declare that he enjoys mountain

climbing for its own sake. He leaves science for others, cares nothing for topography except as ministering to his pastime, and holds a plane-table in abhorrence. Thus between his book and Sir W. M. Conway's "Climbing in the Karakoram Himalayas," there is a great difference. Still this is common to both: a delight in the wild beauty and silent grandeur of the crags, pinnacles and snows of the higher peaks. There is, no doubt, a beauty in the Alps which all the world can see, as Ruskin has truly remarked; but there is another aspect, solemn, almost stern, yet with a strange, thrilling fascination, which he only can appreciate who has grasped their rocky ledges, or planted his ice-axe in their unsullied snows. Vain it is to rebuke Mr. Mummery for treating the mountains like greased poles. He retorts, unabashed, that the pole is slippery, not greasy, and that he enjoys trying to climb it. But he seeks not to vulgarise the mountains; he has no love for the crowd of tourists which now annually deluges the Alps, nothing but contempt for the cockney "mountaineer" who is hauled up a peak by his guides, like a bale of goods, or who makes an ascent simply because it is "the thing to do." Perhaps Mr. Mummery may sometimes carry daring beyond the verge of rashness. It is to be hoped that few readers of this book will be tempted to follow his example of making difficult ascents without guides; for such work requires not only gymnastic skill, but also knowledge and judgment, which very few amateurs can ever acquire. Still it is difficult to avoid sympathising with his love of a struggle—it is the spirit which has made England great, a spirit which is too often lacking in this age of molluscous sentimentality and invertebrate opportunism.

Mr. Mummery's book, as we have said, contains no science and hardly any geography, but those who love the story of a plucky scramble, clearly told in good pithy English, will be loth to lay it down. It is well illustrated, with a number of small sketches introduced into the text, and eleven full-page pictures from either drawings or photographs. One or two of these will repay study as fine examples of the forms of weathered crags. None is better than the photogravure of the lower peak of the Aiguille Grépon. Among the expeditions described are two ascents of the Matterhorn by unwonted routes, a passage of the Col du Lion and Col des Courtes, ascents of the Teufelsgrat (written by Mrs. Mummery), of the Aiguilles des Charmoz, Grépon, du Plan, Verte (also by two unwonted routes), and of the Dent du Requin. The chapters on the Caucasus describe some fine excursions, the chief of which is the first ascent of the Dychtau (17,054 feet) in 1888, a magnificent peak, called in the *Alpine Journal* of that date Koshtantau, for apparently this and a slightly lower summit to the east (climbed by another party in the following year) indulge in a distracting habit of exchanging names. In a concluding chapter Mr. Mummery discusses various moot points in Alpine craft, advocating a preference for "two on a rope" in difficult places, a preference which is not likely to pass unquestioned by some of his brother climbers.

T. G. BONNEY.

*Dairy Bacteriology.* By Dr. Ed. von Freudenreich. Translated by J. R. Ainsworth Davis. (London: Methuen and Co., 1895.)

AN English translation of Dr. Freudenreich's little book appears very appropriately at the present juncture, when serious efforts are at length being made to raise the standard of our dairy produce by providing special courses of study for those engaged in its production. Although some of the peripatetic instruction on dairy-work instituted in various districts by local County Councils has not been attended with the success anticipated, yet there can be no doubt that systematic training in this direction is very urgently required. As the translator truly remarks: "Not only Denmark, but America, France, Germany, and Switzerland are far ahead of us in these matters, and compete against home dairy products with only too much success, while Australia is rapidly becoming another serious rival." The information contained in "Dairy Bacteriology" as to the *scientific* origin of some of the troubles with which, in actual practice, the manufacturer of dairy produce is only too well acquainted, will doubtless be a revelation to many, whilst the instructions given for their successful elimination from the dairy, should at any rate impress the student with the hopelessness of attempting such delicate operations as are involved in dairy work without an adequate knowledge of the various parts played by bacteria in dairies.

The little volume is but an introduction to the subject, otherwise we should have been justified in expecting a better account of the milk-microbes which have been discovered; it is, however, written in an attractive manner, and the author has, moreover, succeeded in making it interesting and readable to the public generally, who as consumers are even more concerned than the manufacturers in the hygienic aspects of our dairy produce.

We note that an edition of this useful little manual has already appeared in French, Italian, and Hungarian, and it only remains for us to congratulate Prof. Davis upon the excellent manner in which he has translated it into English.

*Longmans' School Algebra.* By W. S. Beard and A. Telfer. Pp. 528. (London: Longmans, Green, and Co., 1895.)

SO far as abundance of examples goes, this book is in advance of other text-books of algebra. There are as many as 5200 examples in the book, 500 of which are collected as miscellaneous examples at the end. Teachers who like to have plenty of material upon which to exercise their pupils' minds, will find that this volume satisfies their requirements. It seems hardly necessary, however, to include in a school algebra such a very large number of examples; in our opinion, the volume would have been improved by omitting many of them, and amplifying the very scanty descriptive text.

*Fallacies of Race Theories as Applied to National Characteristics.* By the late W. D. Babington, M.A. Pp. 277. (London: Longmans, Green, and Co., 1895.)

MR. H. H. G. MACDONNELL prefaces these collected essays with a brief statement of the views expressed in them. The late author contended that the mental and moral characteristics of nations are mainly the result of environment, and are not derived from ancestors by heredity. The transmission of physical characteristics is not taken into consideration, and the treatment throughout is more historical than scientific.

*A Chapter on Birds.* By R. Bowdler Sharpe, LL.D., F.L.S. Pp. 124. (London: Society for Promoting Christian Knowledge, 1895.)

EIGHTEEN of our rare avian visitors, and their eggs, are brilliantly depicted by chromo-lithography in this attractive volume for lovers of birds. Dr. Sharpe's notes on the life-histories and natural relations of the different species, furnish instructive reading for young students of ornithology. Such a volume ought not, however, to be published without an index.

*Nature in Acadie.* By H. K. Swann. Pp. 74. (London: John Ball and Sons, 1895.)

FROM the observations of birds, insects, and other forms of life, made by the author while on a voyage to Nova Scotia, and diffusely recorded in this book, it is possible to find notes of interest to naturalists. A systematic list of the species of North American birds mentioned in the text, is given in an appendix.

## LETTERS TO THE EDITOR.

[*The Editor does not hold himself responsible for opinions expressed by his correspondents. Neither can he undertake to return, or to correspond with the writers of, rejected manuscripts intended for this or any other part of* NATURE. *No notice is taken of anonymous communications.*]

### The Size of the Pages of Scientific Publications.

IT was with much surprise that we received the circular of the Royal Society stating that it had been decided to abandon the present size of its *Proceedings* in favour of royal octavo, accompanied by a voting card on the question of a similar change in the size of the *Transactions*. At the Oxford meeting of the British Association, a Committee was appointed, by Section A, to endeavour to secure greater uniformity in the sizes of the pages of the *Transactions* and *Proceedings* of all societies which publish mathematical and physical papers. In view of the report which that Committee will present shortly at Ipswich, it is much to be hoped that the Council of the Royal Society will take no immediate steps toward carrying their recommendations into effect.

A considerable degree of uniformity already exists. The present octavo size of the *Proceedings of the Royal Society* is very nearly the same size as the *Philosophical Magazine*, the *Report of the British Association*, the *Proceedings of the London Mathematical Society*, and of the *Cambridge Philosophical Society*, and many other publications. The *Annalen der Physik und Chemie* is so very little smaller, that reprints from it can be bound up with others from the afore-mentioned sources, without paring down their margins excessively. For papers involving long mathematics or large diagrams, the quarto size of the present *Philosophical Transactions* approximates to uniformity with the *American Journal of Mathematics*, the *Comptes rendus* of the Académie des Sciences of Paris, the *Cambridge Transactions*, the *Edinburgh Transactions*, and numerous other quarto *Transactions*, such as those of the Institution of Naval Architects.

It is very important that specialists in any branch of science should be able to collect, and bind together, reprints of papers on their own particular subjects, and such volumes are of permanent value as works of reference. So long as there are only two sizes to deal with—the above-mentioned quarto and octavo—there is little difficulty about this, but occasionally one comes across a paper of intermediate size, which cannot be bound up with either, and the collection is thus necessarily incomplete. It is hoped that the report, so shortly to be presented, will be a guide to authors of papers in indicating which publications to select, and which to avoid, if they desire to conform to the average standard sizes. Although the work of the Committee is at present confined to mathematical and physical papers, it might perhaps be of advantage that the matter should be discussed in, and representatives on the Committee appointed from the other Sections of the British Association as well. The question of changing the size of the *Proceedings* was recently discussed by the London Mathematical Society, but it was decided to retain the existing form, at any rate for the present, mainly on account of its uniformity with other publications. It will be most unfortunate if the Royal Society takes any retrograde step which may prevent the sizes of its *Proceedings* and *Transactions* from being adopted as the standards.

G. H. BRYAN,
SYLVANUS P. THOMPSON.

### On the Minimum Theorem in the Theory of Gases.

YOU would oblige me by inserting the following lines in NATURE. The last remark made by Mr. Burbury points out, indeed, the weakest point of the demonstration of the H-theorem. If condition (A) is fulfilled at $t=0$, it is not a mechanical necessity that it should be fulfilled at all subsequent times. But let the mean path of a molecule be very long in comparison with the average distance of two neighbouring molecules; then the absolute position in space of the place where one impact of a given molecule occurs, will be far removed from the place where the next impact of the same molecule occurs. For this reason, the distribution of the molecules surrounding the place of the second impact will be independent of the conditions in the neighbourhood of the place where the first impact occurred, and therefore independent of the motion of the molecule itself. Then the probability that a second molecule moving with given velocity should fall within the space traversed by the first molecule, can be found by multiplying the volume of this space by the function $f$. This is condition (A).

Only under the condition, that all the molecules were arranged intentionally in a particular manner, would it be possible that the frequency (number in unit volume) of molecules with a given velocity, should depend on whether these molecules were about to encounter other molecules or not. Condition (A) is simply this, that the laws of probability are applicable for finding the number of collisions.

Therefore, I think that the assumption of external disturbances is not necessary, provided that the given system is a very large one, and that the mean path is great in comparison with the mean distance of two neighbouring molecules.

LUDWIG BOLTZMANN.

9 Tuerkenstrasse, Vienna, June 20.

### Argon and the Kinetic Theory.

THE spectrum exhibited by argon undoubtedly shows that, under the conditions of the experiment, the molecules composing the gas are set into an intense state of vibration, while the ratio of the specific heats (5/3, about) shows, according to the equation $\beta = \frac{2}{3}\frac{1}{\gamma - 1}$, that $\beta = 1$, and therefore the gas is, as pointed out by Lord Rayleigh, monatomic, and cannot therefore be capable of vibrating. But there is, I think, a very simple explanation of this apparent contradiction, and that is, that the above equation is not true, and that it should be, as will be proved hereafter, $\beta = 3k(\gamma - 1)$, where $k$ is very nearly 1 for argon and other so-called permanent gases. This latter equation gives ·2 for the value of $\beta$ in argon, a value easily understood.

The virial equation for smooth elastic spheres *of finite magnitude* is $\frac{3}{2}PV = \Sigma\frac{1}{2}mv^2 - \frac{1}{2}\Sigma Rr$; and since the resilience is unity and $r$ finite, the term $-\frac{1}{2}\Sigma Rr$ cannot vanish. Now the term $\frac{3}{2}PV$ represents work or its equivalent of energy; hence the right-hand member of the equation must represent the same, and since the term $\Sigma\frac{1}{2}mv^2$ is obviously kinetic energy, or its equivalent of work, the term $-\frac{1}{2}\Sigma Rr$ must also represent work or energy. Now we can find the value of $\frac{3}{2}PV$ in terms of $\Sigma\frac{1}{2}mv^2$, as follows. Imagine a cube box so constructed that one side of each pair can be used as a spring to discharge any mass in contact with a velocity $v$. And suppose three smooth elastic spheres each of mass $\frac{M}{3}$ to be discharged by the three spring sides with the above velocity into the interior of the box. Then the work done on each mass will be $\frac{1}{2} \cdot \frac{M}{3}v^2$. Put this equal to PV and take V equal to the volume of the box. The total work done is evidently $3PV = \frac{1}{2}Mv^2$. If, instead of three elastic spheres, we imagine a very great number of very minute ones of the same total mass to be discharged by the spring sides with the same velocity, the energy will be the same as before, and the above equation will still be applicable; and the state of affairs now represented would be that of an ideal gas. But owing to collisions after first starting the velocities of the particles will vary, and therefore we must write the equation

$$3PV = \frac{1}{2}M\overline{v^2}; \quad . \; . \; . \; . \; . \; . \; . \; . \; . \quad (1)$$

where $\overline{v^2}$ is the mean square velocity of the particles. By hypothesis V has the same value in the above equation as in the virial equation; and P can be proved, *if necessary*, to have the same value in the two equations as follows.

If $\bar{f}$ = the *mean* acceleration or retardation, as the case may be, of the cr. of gr. of an elastic sphere impinging directly against a plane; then $\bar{f}t = v$. Also $\bar{f} = \frac{v^2}{2s}$, $\therefore t = \frac{2s}{v}$. Here $t$ is half the time of impact, and $v$ the velocity normal to the plane before and after impact. Now if it can be shown that the time taken by the spring side of our imaginary box to give the same velocity is the same as the above, then it is obvious that the mean pressures in the two cases must be identical.

Assume $s^3$ to be the volume of the cube box, then $s^2$ is the area of each side. Now let the spring side be drawn back so as to act through a distance $s$ on the mass $\frac{M}{3}$ with a constant pressure P per unit of surface; then $Ps^2 \times s = PV$ represents the work done. The velocity given to the mass is $v$, and the acceleration constant. Hence the mean velocity of the spring

side in passing through the distance $s$ is $v/2$, and the time is $s \div v/2 = 2\,s/v$, the same as in the first case. Which proves the proposition.

Since from (1) we have $3\,PV = \frac{1}{2}\,M\overline{v^2}$ or $\frac{3}{2}\,PV = \frac{1}{4}\,M\overline{v^2}$, we may substitute this value in the virial equation, and remembering that $\Sigma\frac{1}{2}m\overline{v^2} = \frac{1}{2}M\overline{v^2}$, we get $-\frac{1}{2}\Sigma Rr = -\frac{1}{4}M\overline{v^2}$. Hence also

$$P = \tfrac{1}{6}\,\rho\overline{v^2}\,.\;.\;.\;.\;.\;.\;.\;.\;.\;.\;(2)$$

where $\rho = \frac{M}{V}$ the density. The above equation is easily obtainable without the use of the virial equation *when the time of impact* is taken into consideration. A phenomenon which cannot be assumed to be instantaneous without upsetting the dynamical definition of the measurement of a force; which expressed algebraically is $Ft = Mv$. From which it is evident that when $t$ the time is 0, $v$ the velocity, is also 0.

When the virial equation is made applicable to the case of a gas composed of molecules capable of vibrating, it seems obvious that the term $\Sigma\frac{1}{2}m\overline{v^2}$ should be written $\Sigma\frac{1}{2}\beta m\overline{v^2}$; because, as shown by Clausius, the internal energy of the molecules bears a constant ratio to the energy of agitation. We must look to the *mechanical structure of the molecule* for the reason of this. Here the fact is simply accepted, not explained; but it is obvious that the same forces which impart translatory energy to a molecule will impart vibratory energy also. The same reasoning applies to the term $-\frac{1}{2}\Sigma Rr$, which now becomes $-\Sigma\beta(Rr)$. The volume of the gas is unaltered by the vibrations, and the pressure is dependent on the two other terms. Hence the equation may be written

$$\tfrac{3}{2}PV = \Sigma\tfrac{1}{2}\beta m\overline{v^2} - \tfrac{1}{2}\Sigma\beta(Rr)\;.\;.\;.\;.\;.\;.\;(3)$$

And from this we get

$$P = \tfrac{1}{6}\beta\rho\overline{v^2}\;.\;.\;.\;.\;.\;.\;.\;.\;.\;.\;(4)$$

The above equation may be written

$$P_2 = \tfrac{1}{6}\rho\overline{v}\,\overline{v}_i\,;\;.\;.\;.\;.\;.\;.\;.\;.\;.\;(5)$$

Where $\overline{v}_i = \beta\overline{v}$. Again equation (2) may be written

$$P_i = \tfrac{1}{6}\rho_i\overline{v}_i^2\,;\;.\;.\;.\;.\;.\;.\;.\;.\;.\;(6)$$

the suffix $i$ denoting that the pressure, density, and mean square velocity are those of an ideal gas composed of smooth elastic spheres.

If $P_i$, $\rho_i$, and $\overline{v}_i$ in (6) are taken respectively equal to $P$, $\rho$, and $\overline{v}_i$ in (5); then it is evident that $\overline{v}_i$ in (5) is the velocity of mean square of an ideal gas which, having the same density, would give the same pressure as a natural gas. Hence $v_i$ can be found from (6). Now the total energy in unit mass of a gas is given by the equation

$$K_vT = \tfrac{1}{2}\beta\overline{v^2}\,;\;.\;.\;.\;.\;.\;.\;.\;.\;.\;(7)$$

where $K_v$ is the specific heat at constant volume, and T is the absolute temperature. From which equation $\overline{v}\sqrt{\beta}$ can be found. We have also from above

$$\overline{v}\beta = \overline{v}_i \therefore \sqrt{\beta} = \frac{\overline{v}_i}{\overline{v}\sqrt{\beta}},\;.\;.\;.\;.\;.\;.\;.\;(8)$$

from which equation the value of $\sqrt{\beta}$ and consequently $\beta$ can be found.

The equation $\beta = 3k(\gamma - 1)$ can now be proved as follows. Multiplying both sides of (4) by V, the volume of unit mass, and combining with (7), we get

$$K_vT = 3PV\;.\;.\;.\;.\;.\;.\;.\;.\;.\;(9)$$

Now from (5) and (6), taking $\rho = \rho_i$ we get $P = P_i/\beta$, and substituting in (9) $K_v = 3P_iV/\beta T$. But $P_iV/T = K_{ip} - K_{iv}$; or the difference between the specific heats at constant pressure and constant volume; the suffix $i$ indicating, as before, that the symbols refer to an ideal gas. Hence

$$\beta = \frac{3(K_{ip} - K_{iv})}{K_v} = \frac{3k(K_p - K_v)}{K_v} = 3k(\gamma - 1)\;\;.\;(10)$$

Here $k$ is some factor which for so-called permanent gases is very nearly unity. For such gases we may write (10)

$$\beta = 3(\gamma - 1)\,;\text{ or }\gamma = \tfrac{1}{3}(\beta + 3)\;\;.\;.\;.\;.\;(11)$$

In the following table the values of $\beta$, except in the case of argon, are calculated from equation (8); and $\overline{v}$, the velocity of ideal gases having the same pressure and density as their corresponding natural gases, at standard temperature and pressure, from (6). The velocities are given in feet per second, and the value of gravity is taken at 32·2. Column (4) gives the values of $\gamma$ for the different gases calculated from equation (11); and column (5) gives the experimental values of $\gamma$. The close agreement between these values is a significant fact.

| | (1) $\beta$ | (2) $\overline{v}_i$ | (3) $\overline{v}$ | (4) $\gamma=\frac{1}{3}(\beta+3)$ | (5) $\gamma$ Experiment | (6) $k$ |
|---|---|---|---|---|---|---|
| Hydrogen | 1·234 | 8551 | 6925 | 1·4115 | 1·412 | 1·00035 |
| Oxygen | 1·197 | 2140 | 1787 | 1·399 | 1·402 | 1·0021 |
| Nitrogen | 1·227 | 2282 | 1860 | 1·409 | 1·411 | 1·0014 |
| Dry air | 1·222 | 2250 | 1841 | 1·407 | 1·409 | 1·0014 |
| Argon | 2 (about) | 1940 | 970 | | 1·7 | |

8, Norfolk Square, W., June 13. C. E. BASEVI.

## Romano-British Land Surface.—Flint Flakes Replaced.

IN the early spring of the present year, whilst passing a newly-opened excavation near Caddington Church, three miles south-east of Dunstable, I noticed a very thin horizontal line of sharp flint flakes, embedded a foot deep from the surface-line of an old pasture. I could see at once that the line represented an old living surface, so I took a few of the flints away. In removing the stones from the soil, one or two little fragments of Romano-British pottery came away with them. The flakes were lustrous,

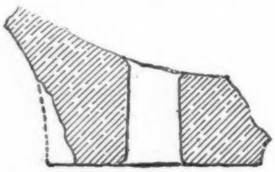

FIG. 1.—Fragment of perforated Romano-British pottery (half actual size).

chiefly black and brown-grey, and as sharp as when first struck. On looking over the flints in the evening, I was able to replace five on to each other. This fact, and the occurrence of the pottery fragments, proved the old surface to have remained intact from Romano-British times.

A little later in the spring, about six square yards of the superincumbent soil were carefully removed for me, when other flakes were found *in situ* to the exact number of four hundred; with these were eighteen fragments of Romano-British pottery, one piece—somewhat like the bottom of a pot—perforated, as here


FIG. 2.—Four conjoined flint-flakes (half actual size).

illustrated. Amongst the flints were two cores, two hammer-stones, three scrapers, part of one edge of a chipped celt, and several neatly chipped but apparently unfinished little implements. A middle-brass Roman coin, too corroded for identification, was found on the same surface in a second excavation close by; with this was a small piece of wood carved to represent a horse's fore-leg, and a well-finished and perfect unpolished flint celt.

In sorting the flints I was able to replace thirty-eight on to each other in groups of from two to five. Two of these groups

are here illustrated—one a group of four, the other of two; the latter shows a straight-edged scraper above, conjoined to a simple flake below.

Hertfordshire conglomerate occurs as a surface stone at the same place, and I have at different times picked up very thin pieces without bulbs which appeared to me to have been artificially flaked. I have, however, kept no disputable objects. Hertfordshire "plum-pudding stone" was certainly flaked by the Kelts of this district, as is proved by the large, faceted and well-bulbed knife-like flake of conglomerate, found by myself at Caddington, here illustrated. This stone is not mentioned as one

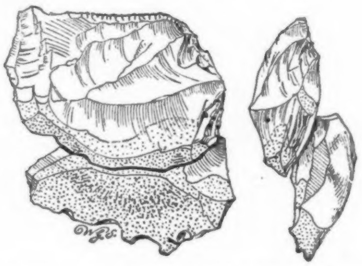

FIG. 3.—Straight edged scraper, conjoined to a flake (half actual size).

known to have been utilised for tools in the list given by Sir John Evans, in his "Stone Implements of Great Britain."

It is difficult to fix a date for the Romano-British living surface here mentioned, as the coin is too corroded for determination; but a correspondent, the Rev. Henry Cobbe, of Maulden, has a Roman coin, found in an adjoining field at Caddington, inscribed "C. CÆSAR AUG. GERMANICUS." If this inscription indicates the Emperor Caligula, as Mr. Cobbe believes, we have a date, A.D. 37–41, and the coin was probably brought over by one of the

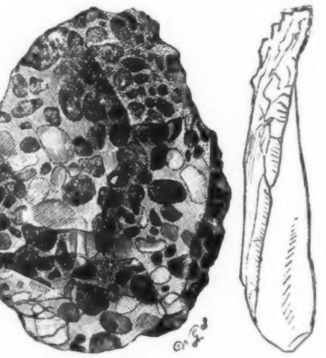

FIG. 4.—Large knife-like flake of Hertfordshire conglomerate (half actual size).

soldiers of Aulus Plautius under Claudius, in the second coming of the Romans in A.D. 43.

A short distance from the old land surface here described is an extensive Roman refuse pit with abundant broken pottery; so that it is safe to assume that a Roman villa once stood close by, and we seem to have evidence of the curious fact of a Kelt sitting down in close proximity to a Roman house and its refuse pit, quietly chipping his stone implements. It is equally curious that the implements and detached flakes have remained undisturbed so near the surface for nearly two thousand years.

Dunstable. WORTHINGTON G. SMITH.

### The Bifilar Pendulum at the Royal Observatory, Edinburgh.

SOME interesting readings of the bifilar pendulum, designed by Mr. Horace Darwin for measuring movements in the earth's surface, were made here at noon on the 9th inst. This instrument, which indicates oscillations in a north and south direction, was erected in March of last year, and daily observation of it has since been carried on, the scale being read off each minute, from five minutes before to five minutes after Paris noon. On the 9th inst. nothing unusual was noticed during the first seven readings, these being all practically the same; but on putting my eye to the telescope for the eighth, I at once noticed that during the interval of less than a minute since the preceding reading, the mirror had rotated considerably about its vertical axis, the normal having moved towards the north, the difference between the seventh and eighth readings being no less than 7·6 mm. of the scale. An immediate examination of the lamp-stand showed it to be perfectly firm. After the regular daily readings were completed, others were made at intervals of generally two minutes, for half an hour after Paris noon. These showed two quite conspicuous oscillations of the mirror during its return to its original position, which it reached about thirteen minutes after noon. It continued to move beyond this point towards the south, till at 0h. 31m. Paris mean time it was 4·1 mm. south of the point at which the scale was first read off. Later readings in the course of the day showed that it was still moving slowly to the south, but no further oscillations were recorded. In the evening, when the mirror appeared to have come to rest, the sensitiveness of the instrument was tested, and with this the column headed "Tilt of mirror-frame" in the following table has been computed. The positive sign indicates a tilt to the north.

| | Paris mean time. | | Scale reading of ray from mirror. | Tilt of mirror-frame in preceding minute. |
|---|---|---|---|---|
| | h. | m. | mm. | ″ |
| June 8 . . | 23 | 55 | 284·2 | |
| | | 56 | 4·1 | −0·005 |
| | | 57 | 4·1 | 0·000 |
| | | 58 | 4·0 | −0·005 |
| | | 59 | 4·0 | 0·000 |
| June 9 . . | 0 | 0 | 4·2 | +0·010 |
| | | 1 | 284·4 | +0·010 |
| | | 2 | 292·0 | +0·385 |
| | | 3 | 2·1 | +0·005 |
| | | 4 | 1·6 | −0·025 |
| | 0 | 5 | 2·3 | +0·035 |
| | 0 | 6 | 2·1 | −0·010 |
| | | 8 | 290·2 | −0·096 |
| | | 10 | 288·7 | −0·076 |
| | | 12 | 7·0 | −0·086 |
| | | 14 | 5·4 | −0·081 |
| | | 16 | 2·8 | −0·132 |
| | | 18 | 2·1 | −0·035 |
| | | 19 | 2·8 | +0·035 |
| | | 21 | 1·4 | −0·071 |
| | | 23 | 0·3 | −0·056 |
| | | 25 | 1·7 | +0·071 |
| | | 27 | 1·3 | −0·020 |
| | 0 | 31 | 280·1 | −0·061 |

THOMAS HEATH.

Royal Observatory, Calton Hill, Edinburgh, June 20.

### Migration of a Water-beetle.

LAST night, at about ten o'clock, a beetle flew in through the open window, alighting on a bowl of roses in the centre of the dining table. On being dropped into a finger-bowl he promptly dived and swam merrily, and proved to be a specimen of the ordinary brown water-beetle, to be found in every pond or ditch of water. Now the nearest water to my dining-room window is the Thames, distant over a quarter of a mile as the crow flies, whence this water-beetle must have flown. Can any of your readers inform me whether such long flights have been observed before in connection with the pairing season or migration of this species? I enclose you a rough sketch of the beetle, not knowing its specific title amongst the Coleoptera.

ROSE HAIG THOMAS.

Basildon, Reading, June 23.

## ARGON AND HELIUM IN METEORIC IRON.

IN the light of the new discoveries of argon and helium, it appeared that the reinvestigation of the gas evolved on heating meteoric iron might promise interesting results. This anticipation has been fulfilled. Meteoric iron, heated *in vacuo*, yields a small amount of both argon and helium, besides a comparatively large quantity of hydrogen.

The investigation of gases occluded in meteoric iron was undertaken by Graham in 1867 (*Proc. R. S.*, xv. 502). From 45·2 grams of a specimen of iron from Lenarto, in Hungary, Graham obtained, by heating it *in vacuo*, 16·53 c.c. of gas, consisting of 85·68 per cent. of hydrogen, 4·46 of carbonic oxide, and 9·86 per cent. of "nitrogen." And eight years later, Prof. Mallet investigated the gases from a specimen of meteoric iron from Augusta County, Virginia, and found 35·83 per cent. of hydrogen, 38·33 per cent. of carbonic oxide, 9·75 per cent. of carbonic anhydride, and 16·09 per cent. of "nitrogen." (*Proc. R. S.*, xx. 365.)

In the same year, Prof. A. W. Wright examined spectroscopically the gases evolved from two meteorites, one the "great Texas meteorite" in the museum of Yale College, which weighs 742 kilograms; another a specimen of meteoric iron from Tazewell County, Tennessee; and a third set of experiments was made with fragments of a meteorite from Arva, in Hungary. The gases obtained were examined spectroscopically, and were found to show the usual spectra of hydrogen, carbon compounds, oxygen, and nitrogen. He was searching for lines present in the spectra of stars, but found none; and he concludes that the spectrum of the solar corona is to be ascribed merely to atmospheric gases. A preliminary account of the examination of a fourth (a stony) meteorite is given in the same journal (*Amer. Journal of Science* [3], ix. pp. 294 and 459), and the full account in vol. x. 44. Suffice it to say that the last fractions of gas evolved contained 6·91 per cent. of "nitrogen." On p. 257 of the next volume (xi.), Prof. Wright gives analyses of the gases from various samples of meteorites, which contain from 1·54 to 5·38 per cent. of "nitrogen." And lastly, in vol. xii. p. 165, he gives further details, including descriptions of spectra, in none of which he noticed anything unusual.

Prof. Wright's interesting papers are instructive, inasmuch as they show how little reliance is to be placed on the evidence of the spectroscope as to the presence of any one gas in a gaseous mixture consisting of a large proportion of other gases. There is no doubt that in future, much attention should be paid to the relative conductivity of gases. The characteristic spectrum of argon is almost completely masked by the presence of a few parts per cent. of nitrogen or of hydrogen; and that of helium is similarly affected, although to a less degree. Though no quantitative experiments have been made on the subject, yet I should judge that the presence of from 5 to 10 per cent. of nitrogen entirely obscures the characteristic yellow line; the other strong lines still remain visible. I hope soon to be able to communicate further information on this interesting subject.

The presence of both argon and helium has been demonstrated in the meteorite from Augusta County, Virginia, a sample of which was purchased from Mr. Gregory. Two ounces of turnings of this meteorite were heated to bright redness in a hard glass tube, all air having been first removed in the cold by a Töpler's pump. From this iron, 45 c.c. of gas were obtained. It was mixed with oxygen in a gas burette, and exploded. It appeared to consist for the most part of hydrogen. After absorption of any carbon dioxide and the excess of oxygen with alkaline pyrogallate, the residue amounted to about half a cubic centimetre. It was transferred to a small tube and dried with a morsel of solid caustic potash, and with it several vacuum tubes were filled. The spectrum showed that it consisted for the most part of argon; the trace of nitrogen which appeared at first rapidly disappeared under the influence of the discharge.

The spectrum was carefully compared with that given by a tube of atmospheric argon, provided with magnesium electrodes. This sample of argon always shows the D lines of sodium, owing to the magnesium electrodes, and proves especially convenient for the detection of helium, the yellow line of which is not coincident with the lines of sodium. Both spectra were thrown into a two-prism spectroscope at the same time, and on careful comparison it was evident that all the argon lines were present. Besides these, the yellow line $D_3$ of helium was faintly visible, not coincident with the sodium lines; and on comparing the spectrum of the gas directly with that of helium from cleveite, it was possible to recognise the identity of the red, blue-green, blue, and violet lines of helium in the meteoric gas. No other lines were visible than those of argon and helium. It may thus be concluded, on spectroscopic evidence, that both argon and helium are contained in meteoric iron, the former in much larger amount than the latter. This conclusion was verified by mixing about 90 per cent. of argon with 10 per cent. of helium. The spectrum of helium, under these circumstances, was much more brilliant than that of argon; hence it may be concluded that less than 10 per cent. of this gaseous residue consisted of helium.

It appeared likely that metallic iron might be induced to absorb argon. It had been noticed, last October, that in attempting to prepare argon by passing atmospheric nitrogen through iron tubes filled with magnesium turnings, and heated to redness, a smaller quantity of argon than usual was collected. This rendered it not improbable that iron at a red heat is permeable to argon. If permeable, then it might be permanently absorbed. An experiment was therefore undertaken by Mr. Kellas, to whom I have to express my indebtedness, to ascertain whether finely divided iron, obtained by the reduction of ferric oxide in hydrogen, would occlude argon.

About 14 grams of the finely divided iron was placed in a combustion-tube, the capacity of which was 53·6 c.c. The tube was connected by a three-way stopcock to a Sprengel's pump and to a water-jacketed reservoir containing argon over mercury. After exhausting the tube, argon was allowed to enter, and the temperature was slowly raised to 600° and maintained for three hours. Until equilibrium of temperature had been established, no perceptible change of volume could be noted. The tube was allowed to cool, connection with the argon reservoir was closed, and the gas was pumped off. The volume, corrected for temperature and pressure, was 54·2 c.c. On heating the tube, about 59 c.c. of gas was given off; it was collected in three fractions, (*a*), (*b*), and (*c*), the heating having been continued for twelve hours.

(*a*) The volume of this gas was 30 c.c. It was collected at about 200° C. This was exploded with oxygen; and a residue was obtained, of which the greater part dissolved in caustic potash, showing that the gas had consisted of hydrogen and hydrocarbons. The final residue was 1·7 c.c.

(*b*) The second fraction, collected at 450°, amounted to 15 c.c., and after treatment as above, the residue was 0·25 c.c. This residue was united with that from (*a*), and a vacuum tube was filled. The flutings of carbon were visible, and also a trace of hydrogen, but no argon. This gas was sparked with 1 c.c. of oxygen, and on absorbing the excess of oxygen with alkaline pyrogallate, 0·45 c.c. remained. On transferring this residue to a vacuum tube, the banded spectrum of nitrogen was alone visible.

(*c*) The third fraction, collected at a red heat, also showed only the spectrum of nitrogen, when purified and transferred to a vacuum tube, and on continuing the discharge it also disappeared and the tube became

phosphorescent. Judging from previous experience, the presence of argon would have revealed itself after the nitrogen had disappeared. It may therefore be concluded that whether iron is permeable to argon at a red heat or not, it does not permanently retain the gas. It is not improbable that the condition of retention may be that the iron is heated to fusion in an atmosphere of hydrogen, hydrocarbons, argon, and helium, and that it is then suddenly cooled. This I should imagine to be the case if the iron were ejected from some stellar body at a high temperature. I am, however, unaware whether any of the lines of the argon spectrum have been identified in the spectra of stars; if not, it is probably because they are masked by the spectra of hydrogen and carbon.

W. RAMSAY.

## *SUBTERRANEAN FAUNAS.*

THE researches of geologists and engineers have revealed the existence of vast tracts of underground waters, often associated with more or less extensive caves. The investigation of these underground waters is interesting to naturalists, as it has led to the discovery of a special subterranean fauna, different in different regions, it is true, but characterised throughout by modifications in certain definite directions. The study of these modifications is a fascinating one, and the problem of their evolution seems to be rendered comparatively easy by the simplicity and limitations of the conditions of life which obtain beneath the earth's surface; for these subterranean forms live in continual darkness, and are exposed to a fairly uniform temperature at all times. It is also, in many cases, possible to tell from what surface-species an underground form has descended, and to infer the age of the latter with a fair approach to accuracy; the nature of the changes undergone, and the rate at which these modifications have taken place, can thus be estimated in particular instances.

It will be remembered that in Packard's well-known memoir on the Cave Fauna of America, the peculiar modifications of subterranean animals were interpreted as lending strong support to the theory of the inheritance of acquired characters. Recently, however, in a careful and interesting memoir on the subterranean Crustacea of New Zealand (*Trans. Linn. Soc.*, London, vol. vi., 1894), Dr. Chilton considers the question from the Neo-Darwinian aspect; and he adduces a number of facts and arguments which greatly tend to reduce the force of Packard's contentions.

Dr. Chilton begins his memoir with a completed account of the New Zealand subterranean Crustacea, including a description of some new species. The underground crustacean fauna of New Zealand has a more varied aspect than that of Europe or North America; of the six species known, three are Amphipods and three Isopods, and these belong to as many as five different genera. Among them *Gammarus fragilis* is interesting to us as being allied to the blind *Niphargus* of Europe. *Cruregens fontanus*, an Isopod belonging to the family Anthuridæ, is curious in possessing only six pairs of legs; the seventh segment is small and without appendages, as is the case also in young Isopods; this larval character is retained in *Cruregens*, probably owing to an arrest in development on account of the scanty supply of food. Two subterranean species of the genus *Phreatoicus* are described, *P. typicus* and *P. assimilis*, n. sp.; a surface species, *P. australis*, lives on the top of Mount Kosciusko in Australia. This genus is peculiar, and the type of a new family of Isopods which approaches the Asellidæ in some respects, but differs in the possession of a laterally compressed body and a long six-jointed pleon.

In addition to the description of these underground forms, the writer gives a *résumé* of our only too scanty knowledge of the habits and conditions of life of subterranean animals. He discusses also the question of the origin of cave forms, and arrives at the conclusion that the New Zealand subterranean crustacea have clearly been derived from a surface fauna, though the affinities of one or two species seem to be rather with marine than with known fresh-water forms. It is pointed out, however, that the cave fauna is not necessarily descended from the present surface fauna of the country; *Crangonyx compactus*, for instance, has its nearest allies in Europe and North America, and the remarkable habitat of the fresh-water species of *Phreatoicus* has already been mentioned.

Cave crustaceans, according to Packard, live "in a sphere where there is little, if any, occasion for struggling for existence between these organisms." Chilton, however, suggests that there is evidence for thinking that Natural Selection has come into play in the evolution of cave animals. He points out that the scanty supply of food must inevitably lead to a keen struggle. Moreover, Packard himself states that the *Cæcidotea* and *Crangonyx* of the North American caves are eaten by the blind crayfish, which in its turn is devoured by the blind fish *Amblyopsis;* so that these animals must struggle with their destroyers. To this end have probably been developed the additional olfactory setæ, described by Packard and others, to enable the pursued animals to escape from their enemies. If there were no occasion for struggling for existence, why should these additional sense organs have been developed at all? At first sight, it certainly seems natural to attribute the degeneration of the eyes, observed in underground forms, to disuse; and it is but a further step to assume that these new characters, resulting from disuse and adaptation to new conditions of life, were inherited by successive generations. But Chilton ingeniously remarks that, if the modifications in the eyes of cave animals were the direct inherited effect of the environment, we should expect to find the lines of modification similar in all animals subjected to the same conditions. This, however, is not the case, as Packard's own investigations have shown. The influences leading to degeneration act uniformly on all individuals, but the modifications produced in the eyes are various, and occur in different ways. In some cases there is total atrophy of the optic lobes and optic nerves, with or without the persistence in part of the pigment (or retina) and the crystalline lens; in others the optic lobes and optic nerve persist, but there is total atrophy of the rods and cones, retina, and facets; while in extreme cases there is total atrophy of the optic lobes and nerves, and all the optic elements. These examples, showing a development apparently capricious and varying in direction in animals all subjected to the same or similar environment, point rather to the action of Natural Selection than to that of the direct inherited influence of the conditions of life.

In a more recent essay in the *American Naturalist* (September 1894), Packard has restated his views on the subject of the modifications of the eyes in subterranean animals, and concludes his remarks with the following words: "That while the heredity of acquired characters was, in the beginning, the general rule, as soon as the congenitally blind preponderated, the heredity of congenital characters became the normal state of things." In support of his view, Packard cites some statistics upon the inter-marriage of deaf-mutes, which have been recently furnished by Prof. Graham Bell. It would appear that, in America at any rate, the segregation of deaf-mutes within asylums has been followed by a striking increase in intermarriages among them; so that, of the deaf-mutes who marry at the present time, no less than 80 per cent. marry deaf-mutes. A marked increase in the number of the deaf-mute population has ensued, and

Prof. Bell points out the danger which consequently exists of the formation of a distinct deaf-mute variety of mankind.

All this is clearly brought out in Prof. Bell's memoir; but Mr. Packard goes so far as to state that Mr. Bell's statistics appear to "almost demonstrate the fact of the transmission of characters acquired during the life-time of the individual," and also says that "deaf-mutes already appear to breed true to their incipient strain or variety, whether congenitally deaf *or rendered so by disease during the life-time of either or both parents*." (The italics are ours). We are thus left in no doubt as to Mr. Packard's interpretation of Mr. Bell's researches; but an attempt on our own part to find in Mr. Bell's pages the particular statistics or remarks which may be regarded as all but demonstrating the inheritance of acquired characters has, remarkably enough, been completely unsuccessful. Mr. Bell's conclusions lend no support to such a view. So far as they bear upon the present subject, they are briefly as follows: (1) That the great factor in determining the production of deaf-muteness in offspring is the existence of a hereditary taint in the direction of deaf-muteness in one or both branches of the family. (2) That this hereditary taint is not the less potent in its effects if it fails to manifest itself in the actual parents of the deaf-mute. (3) That "non-congenital deafness, if sporadic, is little likely to be inherited."

It would thus appear, both from Chilton's presentation of the facts, and from the failure of Packard's appeal to analogy, that—often as the contrary opinion has been urged—the peculiarities of cavernicolous animals do not lend any particular degree of support to the Lamarckian principles of evolution. W. G.

## *PROPOSED BALLOON VOYAGE TO THE POLE.*

DURING the last century many expeditions to the North Pole have been undertaken, but with no result so far as reaching it is concerned. Baron Nordenskiöld, the great Arctic explorer, has made four expeditions to Spitzbergen, and two to Nova Zemlia and Greenland, besides having taken part in the celebrated voyage of the *Vega*. In all explorations both he and others have found the icebergs the chief obstacle; and it may be said that Arctic explorers are now almost all unanimously convinced that the Pole can never be reached in steamer or sledge. Attempts on foot have likewise failed, for the distance of about ten miles has never been exceeded, owing to the great difficulties and dangers.

Notwithstanding these facts, Dr. Nansen, the celebrated Norwegian explorer, attempted yet another way, and instead of cutting a path through the ice, he has allowed himself to be carried polewards by a northerly current. This took place a year and eight months ago, and he has not been heard of since.

Quite recently, at the Royal Academy of Science, Stockholm, an even more perilous project was proposed by M. Andrée, a Swedish engineer. M. Andrée proposes making the expedition in a balloon. The project is not a new one, but it has never been seriously discussed by Arctic explorers. M. Andrée, however, has had much experience in polar regions, having spent the winter of 1882–83 in the far north, and also taken part in the Swedish Meteorological Expedition, which lasted a year. He has also proved himself to be a dauntless aeronaut, his most interesting voyage being one from Gothenburg to the Isle of Gothland, in which he had to cross part of the Baltic. Everything in connection with this proposed expedition has been minutely studied and discussed; and infinite pains have been taken to solve all difficulties.

The balloon would require a double outer covering, and a volume of 6500 cubic yards. The ascensional power thus obtained would be sufficiently great to carry three persons, furnished with provisions for four months, besides allowing for the car being fitted up with necessary instruments for observation, life-buoys, and Berton's collapsible boats. The car could be suspended in such a way as to allow of instant detachment in case of a descent into the sea. The entire weight of the balloon must not exceed about three tons. In the instance of Henri Giffard's captive balloon, exhibited in 1878, and which weighed about six tons, it only required newly inflating after a year's use. According to Graham's observations, a balloon measuring $8\frac{3}{4}$ yards in diameter can be made sufficiently air-tight so as to suffer, per month, merely a loss of $13\frac{1}{2}$ lbs. of its ascensional force. M. Andrée, however, hopes to produce an absolutely impermeable covering.

The balloon, being protected from the wind by a wooden enclosure, would be inflated as far north as possible, by means of hydrogen compressed in cylinders. This once accomplished, it would begin to ascend. To a certain extent it might be steered by means of a sail and several guide-ropes, which, dragging on the earth, form as it were a brake. The ropes, however, would have to be of special composition, in order to produce the same effect in water. The hindrance thus caused to the flight of the balloon, together with the pressure of the wind, would allow the use of a sail. The flight then might reach an angle of 40° away from the wind direction. This steering apparatus, invented by M. Andrée, has often been used by him in his aerial voyages.

Besides the guide-ropes, heavy lines, on which would be placed numbered metal plates, would be attached to the car; these would serve as ballast. In case of a lowering of temperature, and a consequent descent of the balloon, it could be lightened by throwing off these plates, which, if found, would, to a certain extent, show the course taken by the explorers.

Spitzbergen has been chosen as the starting-point, for this island is almost always clear of ice by the middle of June. The departure would take place in July, on a clear day, with a southerly wind. At Spitzbergen the average rate of wind per second is $10\frac{1}{2}$ yards; the guide-ropes would cause a hindrance of about $2\frac{3}{4}$ yards per second, therefore the average rate of balloon would be nearly 8 yards per second, which is about 16 miles an hour. At this rate the Pole should be reached in 43 hours.

The summer is in all respects the most suitable time for an aeronautic voyage in Spitzbergen. The lowest temperature observed at Cape Thordsen in July, 1883, was $+0^{\circ}\cdot 8$ C., and the highest $+11^{\circ}\cdot 6$ C. The movements of the balloon would therefore be very regular. Besides this, there are practically no storms, and the fall of snow in June and July is both slight and rare.

M. Andrée's project has been highly approved of by the most experienced Arctic explorers. Baron Nordenskiöld has declared himself in favour of it, and M. Eikholm, chief of the Swedish Meteorological Expedition to Spitzbergen in 1882–83, states that the conditions of the Arctic regions are most favourable for this voyage. He thinks, moreover, that in the future the balloon will be the principal means of exploring that part of the world.

For many of the above details, we are indebted to an article in the *Revue Scientifique*, by M. Charles Rabot. W.

## *THOMAS HENRY HUXLEY.*

WE regret to announce that, after an illness extending back to last March, and relieved only by two or three brief periods of improving health, Prof. Huxley passed peacefully into the silence of death on Saturday afternoon.

So long ago as 1874, a notice of the life and work of Prof. Huxley was included in our "Scientific Worthies" (vol. ix. p. 257), and Dr. Ernst Haeckel added to it an appreciative notice of his biological labours. These twenty-year-old publications render it unnecessary that any extensive reference to the subject-matter of them should be given now, and, moreover, the chief details of his life are well known.

Huxley was born at Ealing in 1825. His scientific training began in the medical school attached to Charing Cross Hospital, which he entered in 1842. Four years later he joined the medical service of the Royal Navy, and proceeded to Haslar Hospital; from there he was selected to occupy the post of Assistant-Surgeon to H.M.S. *Rattlesnake*, then about to proceed on a surveying voyage in the Southern Seas. The ship sailed from England in the winter of 1846, and returned to England in 1850, after surveying the inner route between the Barrier Reef and the East Coast of Australia and New Guinea. During this period, Huxley sent home several papers, some of which were published in the *Philosophical Transactions* of the Royal Society. His first important paper, "On the Anatomy and Affinities of the Medusæ," was published in 1849. His communications, and the evience of ability which they furnished, led to his election into the Royal Society in 1851.

In 1854, Huxley succeeded his friend Edward Forbes as Palæontologist and Lecturer on Natural History at the Royal School of Mines, a post which he held until his retirement in 1885. He was a great teacher, and the high reputation of the School, now combined with the Royal College of Science, is largely due to his great influence. At the request of the Lords of the Committee of Council on Education, he continued to act as Honorary Dean of the School, and at death he still retained that post. He also agreed to be responsible for the general direction of the biological instruction in the School, so that his place as Professor of Biology has never been filled up.

Huxley was twice chosen Fullerian Professor of Physiology to the Royal Institution, the first time in 1854. In the same year he was appointed Examiner in Physiology and Comparative Anatomy to the University of London. Other posts and honours were crowded upon him. In 1858 he delivered the Croonian Lecture of the Royal Society, when he chose for his subject the "Theory of the Vertebrate Skull." From 1863 to 1869 he held the post of Hunterian Professor at the Royal College of Surgeons. In 1862 he was President of the Biological Section at the Cambridge meeting of the British Association, and eight years later held the Presidency of the Association at the Liverpool meeting. In 1869 and 1870 he was President of the Geological and Ethnological Societies, and in 1872 was elected Lord Rector of Aberdeen University for three years. As might be expected, Prof. Huxley held strong and well-defined views on the subject of education. He was a man who at all times had a keen sense of public duty, and it was this which induced him to seek election on the first London School Board in 1870. Ill-health compelled him to retire from that post in 1872, but during his period of service as chairman of the Education Committee he did much to mould the scheme of education adopted in the Board Schools.

He was elected Secretary of the Royal Society in 1873, and ten years later was called to the highest honorary position which an English scientific man can fill, the presidency of that Society. During the absence of the late Prof. Sir Wyville Thomson with the *Challenger* Expedition, Huxley, in 1875 and 1876, took his place as Professor of Natural History in the University of Edinburgh. From 1881 to 1885 he acted as Inspector of Salmon Fisheries. But this and all his other official posts he resigned in 1885, shortly after which he removed to Eastbourne.

In 1892, more than six years after his retirement, the dignity of Privy Councillor was conferred upon him. The Copley Medal of the Royal Society was awarded to him in 1888, the Royal Medal having been received by him in 1852; and in December last he received the Darwin Medal, the two previous recipients being Dr. A. R. Wallace and Sir Joseph Hooker. His honorary degrees were:—D.C.L. (Oxford); LL.D. (Cambridge, Edinburgh, and Dublin); M.D. (Würzburg); Ph.D. (Breslau). The King of Sweden created him Knight of the Polar Star, and he was elected into most foreign Societies and Academies of Science of note. He was a Correspondant of the Paris Académie des Sciences (Section of Anatomy and Zoology), and Corresponding Member of the St. Petersburg Académie Impériale des Sciences, the Akademie der Wissenschaften, of Berlin and of Munich, the Svenska Vetenskaps-Akademie, Stockholm, the Halle Akademie der Naturforscher, the Academies of Natural Sciences of Philadelphia, Boston and Buffalo, the Göttingen Gessellschaft der Wissenschaften, the Paris Société d'Anthropologie, and the Naturforschende Gessellschaft at Frankfurt-a-M. He was Honorary Member of the Royal Irish Academy, the Accademia dei Lincei at Rome, the Brussels Académie de Médecine, the Institut Egyptien at Alexandria, the Batavia Genootschap van Kunsten en Wetenschappen, the American Academy of Arts and Sciences, National Academy of Sciences, and the Amsterdam Akademie van Wetenschappen. He was also Foreign Member of the Brussels Académie des Sciences, the Haarlem Maatschappij der Wetenschappen, the Philadelphia Academy of Natural Science, and the Società Italiana delle Scienze.

How far-seeing Huxley was, with regard to our present scientific needs, may be gathered from his address when he retired from the presidency of the Royal Society. He saw that scientific literature would have to be organised before it could be fully utilised. His words were: "We are in the case of Tarpeia, who opened the gates of the Roman citadel to the Sabines, and was crushed under the weight of the reward bestowed upon her. It has become impossible for any man to keep pace with the progress of the whole of any important branch of science. . . . It looks as if the scientific, like other revolutions, meant to devour its own children; as if the growth of science tended to overwhelm its votaries; as if the man of science of the future were condemned to diminish into a narrower and narrower specialist as time goes on. . . . It appears to me that the only defence against this tendency to the degeneration of scientific workers, lies in the organisation and extension of scientific education, in such a manner as to secure breadth of culture without superficiality; and on the other hand, depth and precision of knowledge without narrowness." Another point touched upon in the same address was the claims of science to a place in all systems of education. "We have a right," he said, "to claim that science shall be put upon the same footing as any other great subject of instruction, that it shall have an equal share in the schools, an equal share in the recognised qualification for degrees, and in University honours and rewards. It must be recognised that science, as intellectual discipline, is at least as important as literature, and that the scientific student must no longer be handicapped by a linguistic (I will not call it literary) burden, the equivalent of which is not imposed upon his classical compeer." To the expression of such views as these we owe the increased attention now given to scientific instruction in this country, though we have not yet reached the impartial stage to which science has a right.

It may, perhaps, be too early to fix Huxley's real place in Biology. Writing in these columns in 1874, the eminent German naturalist, Haeckel, ranked him among

the first zoologists in England, taking zoology in its widest and fullest signification. "When we consider," he remarked, "the long series of distinguished memoirs with which, during the last quarter of a century, Prof. Huxley has enriched zoological literature, we find that in each of the larger divisions of the animal kingdom we are indebted to him for important discoveries." From the lowest animals he gradually extended his investigation to the highest. In the Protozoa, he was the first to come to satisfactory conclusions concerning the nature of Thalassicollidæ and Sphærozoida; and by his work on "Oceanic Hydrozoa," he greatly extended the knowledge of Zoophytes. His researches upon members of the important group of Tunicata are of great value, and many important advances in the morphology of the Mollusca and Arthropoda are due to him. Further, Huxley especially studied and advanced the knowledge of the comparative anatomy and classification of the Vertebrata. His "Lectures on the Elements of Comparative Anatomy," and his numerous monographs on living and extinct species, afford abundant evidence of what biological science owes to him.

Huxley's place as one who has largely influenced modern thought on many questions, is acknowledged by all to be a very high one. The profound and truly philosophical conceptions which guided him in his inquiries, always enabled him to distinguish the essential from the unessential. First among the subjects which owe their advancement to his support is the theory of biological evolution. When, in 1860, it became his duty as Professor at the Royal School of Mines to give a course of lectures to working men in the Jermyn Street Museum of Practical Geology, he selected for his subject "The Relation of Man to the Lower Animals." The questions arising out of this topic became the subject of warm controversy at the meeting of the British Association in that and subsequent years. The lectures were published in 1863, under the title "Evidence as to Man's Place in Nature," and excited great interest both in this country and abroad. In this and in other works he advanced the principles of the Darwinian theory, and worked out many important developments.

To again quote Haeckel: "Not only has the Evolution Theory received from Prof. Huxley a complete demonstration of its immense importance, not only has it been largely advanced by his valuable comparative researches, but its spread among the general public has been largely due to his well-known popular writings. In these he has accomplished the difficult task of rendering more fully and clearly intelligible to an educated public of very various ranks, the highest problems of philosophic biology. From the lowest to the highest organisms, he has elucidated the connecting law of development. In these several ways he has rendered science a service which must ever rank as one of the highest of his many and great scientific merits."

As a writer of English, Huxley has been unsurpassed in our time and generation. He has set a standard in scientific literature, both in clearness of exposition and in the most perfect handling of words, which it behoves his successors to closely follow. He aimed at writing clearly, and avoided the use of technical language whenever possible. As he remarks in the preface to the volume of "Collected Essays" containing his biological and geological addresses: "I have not been one of those fortunate persons who are able to regard a popular lecture as a mere *hors d'œuvre*, unworthy of being ranked among the serious efforts of a philosopher; and who keep their fame as scientific hierophants unsullied by attempts—at least, of the successful sort—to be understanded of the people. On the contrary, I found that the task of putting the truths learned in the field, the laboratory and the museum, into language which, without bating a jot of scientific accuracy shall be generally intelligible, taxed such scientific and literary abilities as I possessed to the uttermost; indeed, my experience has furnished me with no better corrective of the tendency to scholastic pedantry which besets all those who are absorbed in pursuits remote from the common ways of men, and become habituated to think and speak in the technical dialect of their own little world, as if there were no other."

This Journal especially loses in him one of its best friends. We are now in the second series of fifty volumes, and his was the hand that commenced both of them. His introduction to the fifty-first volume will be fresh in the minds of our readers, and it justified the position he had occupied since 1859, as the devoted apostle of the Darwinian theory. He was, moreover, not only a most valued contributor to our columns, but his advice on many points has been freely asked, given, and followed, during a quarter of a century.

Huxley's wonderful kindness to young men is very well known. He would discuss subjects with his students, and his perfect geniality put them entirely at their ease. Always ready to extend a helping hand, he assisted many to higher ranges than they could otherwise have attained, and by words of encouragement induced others to continue their ascent.

The objects which Huxley stated he had in mind from the commencement of his scientific career are these:—

"To promote the increase of natural knowledge and to forward the application of scientific methods of investigation to all the problems of life to the best of my ability, in the conviction which has grown with my growth and strengthened with my strength that there is no alleviation for the sufferings of mankind except veracity of thought and of action, and the resolute facing of the world as it is when the garment of make-believe by which pious hands have hidden its uglier features is stripped off. It is with this intent that I have subordinated any reasonable, or unreasonable, ambition for scientific fame, which I may have permitted myself to entertain, to other ends; to the popularisation of science; to the development and organisation of scientific education; to the endless series of battles and skirmishes over evolution; and to untiring opposition to that ecclesiastical spirit, that clericalism, which in England, as everywhere else, and to whatever denomination it may belong, is the deadly enemy of science. In striving for the attainment of these objects, I have been but one among many, and I shall be well content to be remembered, or even not remembered, as such."

How nobly he acted up to his principles we all know; how greatly the pursuit of his objects have benefited intellectual and material progress, we can only estimate.

In the preface of the fifth volume of his "Collected Essays," Huxley gives a quotation from Strauss's "Der alte und der neue Glaube," which describes so exactly the guiding principles of his life, that it is difficult to believe the lines were written by another hand nearly a quarter of a century ago. "For close upon forty years," wrote Strauss, "I have been writing with one purpose; from time to time I have fought for that which seemed to me the truth, perhaps still more, against that which I have thought error; and in this way I have reached, indeed overstepped, the threshold of old age. There every earnest man has to listen to the voice within: 'Give an account of thy stewardship, for thou mayest be no longer steward.' That I have been an unjust steward, my conscience does not bear witness. At times blundering, at times negligent, Heaven knows: but, on the whole, I have done that which I felt able and called upon to do; and I have done it without looking to the right or to the left; seeking no man's favour, fearing no man's disfavour."

Huxley leaves a wife and seven children—three sons and four daughters. They mourn the loss of a loving husband and father, and their affliction is shared by all who were fortunate enough to know him as a friend. But his loss will not only be felt by these; it affects the whole

intellectual world. Men will arise who, like him, will advance and extend scientific knowledge by research and exposition, but rarely will the qualities of the investigator and interpreter be combined with a more charming personality.

The funeral has been fixed to take place at Marylebone Cemetery this afternoon, at 2.30 o'clock.

## NOTES.

AMONG the honours which Lord Rosebery recommended on leaving office, and which the Queen has approved, we notice that Dr. Robert Giffen, C.B., whose work in various departments of statistical science will be known to our readers, has become K.C.B., and that Prof. J. W. Judd has been appointed C.B. Mr. James Blyth, the well-known agriculturist, has received a baronetcy, Colonel V. D. Majendie, C.B., has been promoted to K.C.B., and Captain Lugard has been appointed C.B.

THE International Meteorological Committee, at its last meeting at Upsala, in August 1894, recommended that an International Conference of the same character as that of Munich in 1891, should be held at Paris about the middle of September, probably September 15, 1896. A circular has just been distributed among meteorologists, announcing that M. Mascart has undertaken to make the arrangements necessary for the meetings of the conference. Mr. R. H. Scott will be glad to receive, at the Meteorological Office, notes on any questions suitable for insertion in the programme for the conference. It is proposed that the definitive programme shall be prepared before the end of the present year 1895, in order to give meteorologists interested in the subjects proposed for discussion, time to formulate their views thereon.

THE death is announced of Prof. D. Kirkwood, for many years Professor of Mathematics in Indiana State University, and known for his investigations of the orbits of planets and comets.

AN influential committee has been formed in Paris, to collect funds for the erection of a monument to Francis Garnier, the explorer. The Treasurer of the Committee is M. J. Rueff, 43 rue Taitbout, Paris.

PROF. FUCHS has been elected a Correspondant of the Paris Academy of Sciences, in the Section of Geometry; Dr. Nansen has been elected a Correspondant of the Section of Geography and Navigation, and Dr. Laveran a Correspondant of the Section of Medicine and Surgery.

PROF. WILD has formally announced the resignation of his office at St. Petersburg as from September 13. His future residence will be at Zurich, and he requests that papers and books hitherto addressed to him at St. Petersburg, should be sent to his new address.

THE subject of the essays for the Howard Medal of the Royal Statistical Society, to be awarded in 1896, with £20 as heretofore, is "School Hygiene, in its Mental, Moral, and Physical Aspects." Essays should be sent in on or before June 30, 1896.

PROF. C. LLOYD MORGAN has accepted an invitation to deliver four lectures in the Columbia University Biological Course next winter. His subject will be "Some Habits and Instincts of Birds." Mr. Frank M. Chapman, of the American Museum of Natural History, will also give four lectures upon birds, from the zoologist's standpoint.

THE American Museum Expedition of 1895 has already completed the exploration of the Uinta basin fossil fauna, and established the fact that, like the *Phosphorites* of France, it is completely transitional between the Eocene and Miocene. The party is now passing north to explore Brown's Park on the eastern base of the Uinta Mountains, an ancient lake basin which has been long known but hitherto unexplored for fossils.

THE Executive of the Midland Union of Naturalists at their annual meeting, held on Monday last at Oxford, awarded to Mr. Walter E. Collinge, Assistant-Lecturer in Zoology and Comparative Anatomy, Mason College, Birmingham, the "Darwin Medal" for his recent researches on the cranial nerves and sensory canal system of fishes.

MR. GEORGE S. DAVIS, who, since January 1885, has at a very heavy loss maintained the "Index Medicus," announces he will be obliged to discontinue that very useful publication, owing to insufficient support. It would hardly be to the credit of medical societies, and scientific workers generally, if this indispensable monthly index is allowed to come to an end for want of something like £400 a year.

THE fortieth annual exhibition of the Royal Photographic Society will be inaugurated on Saturday, September 28, by a private view, followed in the evening by a conversazione. The exhibition will remain open daily (Sundays excepted) from September 30 until November 14. Medals will be placed at the disposal of judges for the artistic, scientific, and technical excellence of photographs, lantern slides, and transparencies, and for apparatus. The judges for the technical section are Captain W. de W. Abney, Mr. Chapman Jones, and Mr. Andrew Pringle.

AN International Exhibition of Hygiene, organised under the direction of M. Brouardel, was opened at Paris on Thursday last. The exhibits are divided into five groups, referring respectively to (1) the hygiene of private houses; (2) city hygiene; (3) the prophylactics of zymotic diseases, demography, sanitary statistics, &c.; (4) the hygiene of childhood, including alimentary hygiene, questions of clothing, and physical exercises; (5) industrial and professional hygiene.

THE *Weekly Weather Report* of the 29th ult. shows that the rainfall for the first half of this year is much below the average in all districts except the north-east of England. The deficiency varies from 2·5 inches in the east of Scotland, to 5 inches in the south-west of England, but in the west of Scotland the deficiency amounts to 12 inches. Some heavy amounts have, however, been measured recently; at Churchstoke, Montgomery, the abnormally large fall of 4·83 inches was recorded on the 26th ult.

A FEW days ago, the Lord Mayor of Liverpool, on behalf of the Museum Committee of the Corporation (of which Sir William B. Forwood is chairman), opened in the Public Museum, in presence of a numerous assembly, a large new gallery exclusively devoted to ethnography. An interesting account of the origin and history of the collection, and of the method of its arrangement, was given by Dr. H. O. Forbes, the Director of Museums. The African, Papuan, and New Zealand sections are especially rich, while those of Mexico, Peru, and Patagonia contain some very rare exhibits of exceptional value.

AT the annual general meeting of the Society of Arts, the following gentlemen were elected Vice-Presidents:—Sir Edward Birkbeck, Mr. B. Francis Cobb, the Hon. Sir Charles W. Fremantle, Sir Douglas Galton, and Prof. W. C. Roberts-Austen. To fill the places vacated by retiring members of Council, there were elected, at the same meeting, Sir Steuart Colvin Bayley, Major-General Sir Owen Tudor Burne, Mr. R. Brudenell Carter, and Dr. Francis Elgar. Sir Frederick Bramwell was elected Treasurer of the Society.

THE following recent appointments are announced in *Science*. To be assistant professors in Johns Hopkins University: Dr. C. Lane Poor, astronomy; Dr. A. S. Chessin, mathematics and mechanics; Dr. Simon Flexner, pathology; Dr. Albert Mann to be professor of biology in Ohio Wesleyan University. In Syracuse University, Dr. E. C. Quereau to be professor of geology and mineralogy, and Dr. W. H. Metzler associate professor of mathematics. Mr. M. A. Mackenzie has been appointed professor of mathematics in Trinity University, Toronto. The chair of physics in the University of California, recently filled by the late Prof. Harold Whiting, has been offered to Dr. E. P. Lewis.

A NOVEL engineering scheme in the construction of the foundation of the retaining wall of the new speedway at High Bridge, in New York City, is the freezing of a bed of quicksand which impeded the work. A row of 4-inch pipes have been sunk a few feet apart, to the depth of 40 feet. These pipes are capped at the bottom, and inside them are inserted smaller pipes, open at the bottom. Cold air is forced from a condenser through the smaller pipes into the larger, and thence returned to the condenser. The air is cooled by expansion to a temperature of about $-45°$ C., thus freezing the surrounding mud and wet sand, and checking the flow into the excavation.

THOSE who have read Prof. Crum Brown's "Robert Boyle" Lecture, reported in our columns (vol. lii. p. 184), will be interested to learn that among the "Studies from the Princeton Laboratory," contributed to the current number of the *Psychological Review*, there is a paper on "Sensations of Rotation," by Mr. H. C. Warren. The particular object of this investigation was to determine the relative influence of sight and the internal sense of rotation on the subjective estimate of movement. By means of a mirror—which could be inserted or removed at will—the apparent motion, as given to sight, could be reversed. For the detailed results the paper itself must be consulted. In general they seem, we are told, to favour the view that the semicircular canals constitute the organ for the sense of rotation.

THE Meteorological Office has received from the Central Physical Observatory of St. Petersburg, copies of a circular addressed to various institutions with reference to a proposed meteorological exhibit at Nizhny-Novgorod Exhibition in 1896. The Central Physical Observatory being desirous of making this exhibit as complete as possible, and at the same time of making known to the Russian public the progress of meteorological science in various countries, desires to obtain information on any of the following points:—(1) Number of stations, of different orders. (2) Titles of periodical publications, any of which will be exhibited. (3) Summary of practical applications of meteorology, with titles of any works on the subject. (4) Copies of works containing mean values or references to them, instructions for taking observations, descriptions of instruments with methods of exposure, and charts referring to maritime meteorology.

THE autumn meeting of the Iron and Steel Institute will be held at Birmingham from Tuesday to Friday, August 20–23. The programme will embrace visits to the leading industrial establishments in and around Birmingham. The Mayor of Birmingham will hold a reception, at the City Council House and Art Gallery, on the evening of August 20. The Earl and Countess of Warwick will also give a reception at Warwick Castle. Among the papers that are expected to be read are:—"The Thermo-chemistry of the Bessemer Process," by Prof. W. N. Hartley, F.R.S.; "The Hardening of Steel," by H. M. Howe; "The Mineral Resources of South Staffordshire," by H. W. Hughes; "On Tests of Cast Iron," by W. J. Keep and by T. D. West; "The Estimation of Oxide of Iron in Steel," by A. E. Tucker; "The Use of Nickel in the Metallurgy of Iron," by H. A. Wiggin.

PROF. KIKUCHI, of the Science College, Tōkyō, is preparing a short life of the late Prof. Cayley, to be accompanied by a photograph, for a Japanese popular scientific monthly, viz. the "Tōyō Gakugu Zasshi."

A REMARKABLE system of electric lights on buoys has just been completed at the Gedney Channel, off Sandy Hook. This channel is only 1000 feet wide, and vessels have not heretofore been able to pass through it by night. The new system, however, provides a brilliant thoroughfare, lighted by ten incandescent lights of 100 candle-power each, and each on a buoy, about 50 feet long, and rising 12 feet out of water. The cable which conveys the electricity carries the pressure of 1000 volts under water, and is six and half miles long, being the longest cable in the world carrying a high-pressure current under water, and also the only one of its kind ever made. It consists of a copper conductor, insulated with gutta-percha, bedded in jute, and sheathed with hard drawn copper wire. The machines have an output of only 100 volts, but the current flows through a step-up converter, back of the switchboard, where it is converted into the required voltage, thus being perfectly safe to operate.

THE palæontological department of the American Museum has recently secured by purchase the entire collection of fossil mammals of North America brought together by Prof. E. D. Cope since 1870. This includes 552 of Prof. Cope's mammalian types, besides the unique single skeletons of Phenacodus, Hyracotherium and Hyrachyas, and the rich series from all formations described and figured in Cope's Tertiary Vertebrata, besides all his unpublished material. This famous collection, together with the others which are rapidly coming in from the annual western expeditions to the Rocky Mountain region, will be arranged in the large new hall upon the geological floor of the Museum, which has been designed and cased for the purpose. The collections are being prepared for exhibition and research as rapidly as possible.

BY the kindness of Mr. R. H. Scott, we are able to print the following information received at the Meteorological Office with reference to some recent earthquake disturbances in the Leeward Islands. The note was drawn up by Mr. F. Watts, the Government Analytical Chemist at Antigua, and was sent to the Colonial Office with two letters on the effects of the earthquake in Barbuda. "On Monday, May 20, 1895, a long and somewhat severe earthquake shock was felt in Antigua at 4.44 p.m. This shock threw down a steel rod 4 inches long and $\frac{1}{4}$ inch in diameter, in a rough earthquake indicator at Skerretts. Slight shocks followed at intervals. I was able to ascertain that there were at least seven shocks between 4.44 and 8.20 p.m. A shock at 6.58 p.m. was rather severe, causing one of the Cathedral bells to sound slightly and stopping the clock. Slight shocks have been experienced almost every day since. Similar shocks are reported from Montserrat, Nevis, St. Kitts, and Barbuda. Some injury to buildings is reported from Barbuda, but I am unaware of the extent of the damage. It is stated that distant sounds, as of explosions, were heard in Barbuda; these appear to have been heard in a northerly direction. Through the courtesy of the Telegraph Company, I am informed that these earthquakes have not been felt in any islands save those in the groups Antigua, Montserrat, Nevis, St. Kitts, Barbuda. From this fact, coupled with the report of noises heard in Barbuda, I should infer that these disturbances are purely local, and in no way related to the earthquakes in Europe about the same time."

AN elaborate investigation on the bacterial contents of margarine and margarine-products has been recently made by Messrs. Jolles and Winkler. It is satisfactory to find, in view of the large quantities of margarine which are placed on the

market in one form or another, that it is considerably freer from microbes than ordinary butter when the latter is not made with Pasteurised cream. Whereas butter contains an average of from 10 to 20 millions of microbes per grm., margarine-butter yields but from 4 to 6 millions; moreover, whilst in extreme cases as many as 47 millions of microbes have been found per grm. in butter, margarine can only boast of at most something over 11 millions. Cold appears to act more prejudicially on margarine microbes than it does on butter germs; thus in one case a reduction from $6\frac{1}{2}$ millions to 230,200 per grm. was observed in margarine, whilst a similar exposure never succeeds in eliminating more than one-third of those present in butter, according to Lafar. It is reassuring to learn that in none of the numerous samples examined were pathogenic bacteria discovered; many of the ordinary microbes present were isolated and described, and amongst these two were found which the authors believe are closely associated with rancid processes which occur in old samples of margarine. To further reduce the microbial population of margarine butter, it is suggested that only sterile milk and sterile water should be used in its manufacture from oleo-margarine, which is considerably poorer in bacterial life than the finished product.

IN the years 1891 and 1892, the Norwegian Government fitted out a vessel for the purpose of making temperature observations round the Lofoden Islands, with the view of tracing the connection between the habits of the cod and the temperature of the water, and the Parliament voted a sum of money for the purchase of thermometers for registering the temperature at various depths. We have received from Lieutenant G. Gade, who was entrusted with the investigation, a pamphlet entitled "Temperaturmaalinger i Lofoten," which contains an interesting account of the results obtained. He found that at the same places the temperature sometimes increased regularly according to the depth, while at others there were two distinct strata of water, the cold being uppermost. Although the vertical variations of temperature may have been considerable, yet he always found an increase with depth. The favourite temperature of the cod is supposed to be 5° C., and while in January 1892 this was found at the surface, in March 1891 it was only found at a depth of 160 metres; the greatest depth at which fishing takes place is 200 metres, where 6°–7° C. were recorded nearly constantly from January to the middle of April. Lieutenant Gade found that when there were two strata of water, one cold (2°–3° C.) uppermost, and one warmer (5°–7° C.) below, the cod was always found in the warmer stratum; but, as the fishing takes place at depths where the temperature is from 4°–7° C. or more (and the depths where these temperatures are found are very different), the author considers that the fisherman cannot derive practical advantage from temperature observations alone.

CHORISIS, or the doubling of the parts, is by no means a rare occurrence in flowers. In this phenomenon there appear, apparently in the place of one floral leaf, especially a stamen, two such leaves either collaterally, *i.e.* beside one another, or serially, above one another. These pairs of leaves may arise either out of a single common primordium, or directly from the axis. Up to the publication of a paper on "Das Reductionsgesetz der Blüthen," by Dr. Lad. J. Čelakovský (Stzb. der königl. böhmischan Ges. der Wissenschaften), morphologists agreed in regarding chorisis as the division or branching of an originally simple leaf. Dr. Čelakovský, however, comes to the following conclusions, amongst others, after a very complete consideration of a large number of instances. Normal chorisis occurs not as a division of a single leaf, but rather as a fusion, or at least an approximation of distinct and originally uniformly separated leaves. In the ontogeny of the plant this may occur as a branching or positive chorisis, as he terms it, of a single primordium, but this fact does not afford, according to him, a clue to the steps in the phylogenetic development, by which the present state has come about; but he believes, in opposition to the hitherto received opinion, that the present condition in these flowers was attained by negative chorisis or approximation. Normal chorisis is the expression of an incomplete transition from a state in which the individual leaves composing a whorl or whorls were more numerous, into one in which they are less numerous. It is, in fact, the resultant of two tendencies—one, the older, to polymerism, and the other and newer, to oligomerism. The reduction so effected is always governed by the law of the alternation of the consecutive leaf-whorls. Dr. Čelakovský's paper is one of great interest, and the discussion as to the origin of the various types of andrœcium will no doubt be specially useful to those who are interested in the affinities of the natural orders of dicotyledons and monocotyledons.

THE publishers of *Knowledge* announce that Dr. Isaac Roberts, F.R.S., will shortly continue in that magazine his selection of photographs of stars, star-clusters, and nebulæ. The series is intended to be in continuation of Dr. Roberts's work, "A Selection of Photographs of Stars, Star-Clusters, and Nebulæ," recently published, and which has contributed very largely to the extension of the knowledge of astronomical phenomena.

THE July number of *Natural Science* is devoted to brief descriptions of the results of the *Challenger* Expedition, from the points of view of investigations in many branches of knowledge. Each of the contributors, all of whom write with authority upon their respective subjects, more or less confines himself to answering the question, "How has the *Challenger* Expedition advanced science?" The brief summaries thus obtained form a very valuable and compact index to the advances in various fields of natural knowledge due to the Expedition.

THE additions to the Zoological Society's Gardens during the past week include a Bonnet Monkey (*Macacus sinicus*, ♀) from India, presented by Mr. John Norbury, Junr.; a Macaque Monkey (*Macacus cynomolgus*, ♂) from India, presented by Mr. H. W. Ball; a Black-eared Marmoset (*Hapale pencillata*) from South-east Brazil, presented by Mr. H. P. Roberts; a Rough Fox (*Canis rudis*) from British Guiana, presented by Dr. Irvine K. Reid; a Grey Ichneumon (*Herpestes griseus*) from India, presented by Lady Champion de Crespigny; seven Black Salamanders (*Salamandra atra*), a Slowworm (*Anguis fragilis*) from Switzerland, presented by the Rev. J. W. Horsley; a Burchell's Zebra (*Equus burchelli*, ♂) from South Africa, a Common Rhea (*Rhea americana*) from South America, deposited; two Black-necked Swans (*Cygnus nigricollis*) from Antarctic America, three Blue Snow Geese (*Chen cœrulescens*) from Alaska, purchased; a Thar (*Capra jemlaica*, ♀), born in the Gardens.

## OUR ASTRONOMICAL COLUMN.

VARIABLE STARS.—Dr. Chandler has completed a revised supplement to his well-known second catalogue of variable stars; together they furnish a complete list of known variables, comprising in all 344 stars. Some little difficulty has been experienced in connection with the southern variables, on account of the want of accurate positions and certain identifications in some cases. Dr. Chandler especially shows a want of confidence in the data relating to the variables discovered photographically at the Boyden station of the Harvard College Observatory at Arequipa, ; but considering the pressing need of a definitive nomenclature, and relying on the assurances of Prof. Pickering, most of these objects have been included in the catalogue and letters assigned to them.

All the recent observations made by the South African ob-

server, Mr. Roberts, have also been included in the new catalogue. (*Astronomical Journal*, No. 347.)

The Temperature of the Sun.—A new method of determining the temperature of the sun has been employed by H. Ebert (*Astrophysical Journal*, June). With the aid of data supplied by Langley's investigations, Rubens deduced the law that the wave-length of the maximum energy is inversely proportional to the square root of the absolute temperature of the radiating body. Experiments on the radiation of blackened bodies between absolute temperatures 373° and 1088° indicated the relation

$$\lambda\sqrt{T} = 123,$$

T being the absolute temperature, and λ being expressed in microns ($\mu = \cdot 001$ mm.). Langley has shown that the maximum energy of the continuous background of the solar spectrum is very nearly at 0·6 μ, and assuming that the incandescent particles in the sun which yield the continuous spectrum are comparable to a black body as regards their total radiating capacity, the application of the above formula gives a temperature of about 40,000° C. The parts of the sun to which this temperature applies are stated to belong to the interior regions, below the photosphere.

Dr. Ebert enters into a discussion of the electromagnetic nature of the solar radiation, in order to justify the application of the formula in the case of the sun. This leads him incidentally to suppose that the continuous background of the solar spectrum is mainly due to hydrogen in a strongly compressed state.

The Rotation of Saturn.—In 1893 Mr. Stanley Williams announced some highly interesting facts with reference to the period of rotation of Saturn, as deduced from observations of spots on different parts of the surface of the planet (Nature, vol. l. p. 32). The observations were continued during the opposition of 1894, and similar striking results have been arrived at. (*Monthly Notices*, vol. lv. p. 354). It was again found that the spots indicated widely different rotation periods in the same latitude, but in different longitudes, as shown in the following table:—

| | Range in longitude. ° ° | Mean period. h. | m. | s. |
|---|---|---|---|---|
| Dark spots (17°–37° N.) | 30–130 | 10 | 14 | 57·29 |
| | 140–200 | | 14 | 44·23 |
| | 240–360 | | 15 | 47·97 |
| Bright spots (6° S.–6° N.) | 0–80 | | 13 | 1·69 |
| | 80–160 | | 12 | 40·03 |
| | 160–360 | 10 | 12 | 25·83 |

The average rotation periods of the whole equatorial spot zone during the four years of observation were as follows:—

| | h. | m. | s. | | s. |
|---|---|---|---|---|---|
| 1891 | 10 | 14 | 21·8 | Diff. | 43·6 |
| 1892 | | 13 | 38·2 | ,, | 45·8 |
| 1893 | | 12 | 52·4 | ,, | 16·6 |
| 1894 | 10 | 12 | 35·8 | | |

The extreme difference of 1m. 46s. observed since 1891 "means a very considerable increase in the velocity of motion of the surface material, amounting to 66 miles per hour. In other words, the great equatorial atmospheric current of Saturn was flowing 66 miles an hour more quickly in 1894 than it was in 1891."

Taken as a whole, the observations indicate a more rapid rotation of the planet in the equatorial regions than in the northern zone of spots, and they appear to establish that there are great differences of velocity in different longitudes.

To Prof. Darwin, these results "suggest a rather wild consideration" (*Observatory*, June). He considers it possible that sections of the planet parallel to the equator may not be circular, and suggests that it might be worth trying to detect systematic differences between the various equatorial diameters by micrometric measurements.

## *THE VISIBILITY OF SHIPS' LIGHTS.*

It may be remembered that in 1890, the German Marine Observatory tested some three thousand running lights in use on board ships, and found two-thirds of them defective. Further tests of the visibility of lights of known candle-power were made by the German Committee last year, and some of the results obtained are noted in a leaflet just distributed to seamen by the U.S. Weather Bureau. The law of emission for a white light is that its visibility is proportional to the square root of its candle-power, and the results of the experiments by the Committee closely follow the law, the departures being no greater than the estimated errors of position of the vessel. The mean of a large number of observations gave as the distance at which a white light of one candle-power became visible 1·40 miles for a dark clear night, and 1·00 mile for a rainy one. Experiments undertaken in America, after the International Maritime Congress in 1889, gave the following results in very clear weather: A light of 1 candle-power was plainly visible at 1 nautical mile, and one of 3 candle-power at 2 miles. A 10 candle-power light was visible with an ordinary binocular at 4 miles; one of 29 candles faintly at 5, and one of 33 candles visible without difficulty at the same distance. On a second evening, exceptionally clear, a white light of 3·2 candle-power could readily be distinguished at 3, one of 5·6 at 4, and one of 17·2 at 5 miles. The Dutch governmental experiments, conducted at Amsterdam, gave the following results: A light of 1 candle-power was visible at 1 nautical mile; 3·5 at 2, and 16 at 5 miles. Experiments with green lights gave 0·80 as the distance in miles at which a green light of a single candle-power is just visible. The candle-power required for a green light to be visible at 1, 2, 3, and 4 nautical miles was 2, 15, 51, and 106, respectively. The American experiments before referred to give for green light: 3·2 candle-power fairly visible at 1 mile, and 28·5 clearly at 2 miles, these results being, however, from a limited number of experiments. The German trials were much more numerous. The extraordinarily rapid diminution of the visibility of the green light with the distance, even in good observing weather, and the still more rapid decrease in rainy weather of a character which will but slightly diminish the intensity of a white light, show that it is of the utmost importance to select for the glass a shade of colour which will interfere with the intensity of the light as little as possible. The shade recommended is a clear blue-green. Yellow-green and grass-green should not be employed, as they become indistinguishable from white at a very short distance. For the red, a considerably wider range is allowable, but a coppery-red is said to be the best.

## *THE RELATIVE POWERS OF LARGE AND SMALL TELESCOPES IN SHOWING PLANETARY DETAIL.*

It is to be hoped that a definite understanding will soon be arrived at regarding the differences between large and small telescopes in revealing delicate surface-markings on Mars, Jupiter, and Saturn. The subject of relative efficiency was discussed about ten years ago, and some interesting evidence was evoked as to the different forms and sizes of telescopes, but no settlement of the question was possible in the face of the diversity of opinion existing. The time seems to have come when the subject may be suitably referred to, and the facts considered apart from mere prejudice or preference for any kind or size of instrument.

The phenomenal results recently claimed for certain small telescopes are almost of a character to shake even the faith of those disposed to acknowledge their great utility on several classes of objects, for our confidence cannot go beyond reasonable limits. In individual cases a good though small instrument, an acute well-trained eye, acting in combination with the best atmospheric conditions, will yield surprising results; but some of those lately published border upon romance, and henceforth it would seem that if all the data derived with such means are to be absolutely accepted, then large telescopes are grossly incapable on certain important objects, and may as well be packed away in the lumber rooms of our observatories.

This is the more surprising when we consider the opinions expressed during the discussion which previously took place on the same subject. Prof. C. A. Young, who has charge of the 23-inch refractor at Princeton, said: "I can almost always see with the 23-inch everything I see with the 9½-inch under the same atmospheric conditions, and see it better—if the seeing is bad only a little better, if good immensely better." Other observers having the means of comparing large and small instruments, side by side, furnished similar evidence, except in the case of M. Wolf, of Paris, who said: "I have observed a great deal with two instruments (both reflectors) of 15·7 and 47·2 inches aperture. I have rarely found any advantage in using the larger one when the object was sufficiently luminous." Prof. Asaph Hall, whose

valuable work with the 25·8-inch refractor at Washington is so well known, once said: "The large telescope does not show enough detail." The testimony was not, therefore, unanimously in favour of big telescopes.

More recently the 36-inch at Mount Hamilton has been eulogised for its fine performance. Mr. Keeler, in January 1888, said that the minutest details of Saturn's surface were visible with wonderful distinctness with this instrument. The 12-inch and 6-inch refractors at the same observatory were found far inferior in capacity to the 36-inch. Prof. Barnard has also stated: "Let the conditions be the best for observing, with the air steady, and the 36-inch is far ahead of the 12-inch." The same observer has also remarked: "350 is the most useful power on Jupiter and Mars, 520 on Saturn." For planetary work he prefers using the full aperture and low powers.

We have it on the authority of most of those who have employed both large and small telescopes, and are therefore in the best position to speak as to their relative merits, that large instruments in good air will reveal more than small ones. The observer would in preference use the largest instrument for any critical purpose; and this being so, how shall we explain their apparent failure in regard to planetary details? Is it that the big telescopes show too little, or that the small instruments exhibit too much?

And here it may be noted that only in exceptional cases do we find phenomenal results accruing from the use of small apertures. It is not every one who has a telescope of 6 or 8 inches diameter who can discover the various spots and numerous belts on Saturn, or trace the double and often interlacing canals of Mars.

During the last few years numerous dark and light spots have been detected on the ball of Saturn by Mr. A. S. Williams, who used a 6-inch reflector. These have been distinguished when Saturn was nearing conjunction with the sun, and in spite of two unfavourable circumstances—namely, the small diameter of the planet, and its proximity to the horizon. The spots have been seen so distinctly, that the observer has been enabled to describe them individually as bright or faint, small or large, round or oval, &c. These observations have not, perhaps, been fully corroborated, though several observers appear to have glimpsed the markings alluded to. When we consider that many hundreds of amateurs have been employing their telescopes upon Saturn without seeing the spots, the affirmative evidence of a few isolated persons can hardly be regarded as conclusive. It is a fact that, if any new feature on a planet, or an unknown companion to a star were confidently announced, a few of the many observers who looked for it would certainly assert they could see it though not really existing.

Prof. Hough, with the 18½-inch refractor, at Chicago, made a series of observations in 1884 and 1885 for the special purpose of detecting definite markings on Saturn and redetermining the rotation period, but he quite failed to get the necessary data. His statement was: "The belts on the disc of the planet were at times quite conspicuous and very sharply defined, but we were unable to find any spot or marking by which to observe rotation." Yet the *Monthly Notices* for June 1884 contain a drawing which gives a numerous array of condensations attached to the dark narrow belt bounding the equator on its southern side. This drawing was made with an 8½-inch reflector, and at about the same period many other observers examined the planet with an entirely negative result as far as the existence of these condensations was concerned. A drawing was published in the *Journal* of the British Astronomical Association for July 1894, showing the planet as he appeared on March 26 of that year in a 12-inch reflector. A numerous assemblage of dark belts are shown, and many other observers appear to have seen several comparatively narrow belts. Prof. Barnard, however, using the 36-inch refractor in re-measuring the dimensions of Saturn and his rings in 1894, was led to pay some attention to the physical appearance of the planet, and significantly remarks: "But one dark narrow belt was seen upon the planet. The black and white spots recently reported with small telescopes were not seen at any time." It is certainly a remarkable circumstance that the belts and spots, if really existing, cannot be seen in the large instrument. Are the observers with small apertures suffering from some extraordinary hallucination, or must we consider that the brightness of the image in large telescopes and inferior definition are sufficient to obliterate very delicate markings? Is the glare sufficiently strong to overcome the slight contrasts of tone readily perceptible on a fainter image? Prof. Holden thus expressed himself in 1891: "There is no doubt that the belts on Saturn are often marked and mottled with brighter spots. I presume that such spots would be as easily seen in a small but perfect telescope as in a larger one. Seeing such faint markings is entirely a matter of detecting faint contrasts, and these should be detected as readily in a small instrument as in ours, if not more readily, except that the large size of our image helps us." On the other hand, Prof. Young has suggested that faint images are very encouraging to the imagination, and therefore often a source of observational errors.

Prof. Holden's remarks are tantamount to an admission that large instruments are ineffective on planetary details, for what are delicate markings but "faint contrasts"? Yet it would be conceived that the 36-inch had proved itself quite capable of dealing with such contrasts, for it is stated by Prof. Barnard, from observations of Jupiter in September–October 1894: "The red spot is fairly distinct in outline, though quite pale—a feeble red. The following end of the spot is quite dark. There are white regions on its surface. The belt south of it seems to be in contact with the spot, if it does not actually overlap it slightly."

The 36-inch is mounted in one of the finest localities for celestial observations, but shows nothing on Saturn but the dark narrow belt situated in the midst of the equatorial zone, while certain telescopes of small aperture reveal the disc furrowed with belts and mottled with spots. Nearly every small telescope shows more than one belt upon Saturn, but the delineations seldom agree as to the number or latitudes of these belts. We ought to expect approximately accordant positions; but the majority of drawings are hurriedly executed and based on rough estimations, so that they are often found inconsistent. The differences referred to are not, therefore, proof of the non-existence of the objects depicted, for the same disagreements are found with reference to well-assured formations. In some cases undoubtedly observers will, perhaps unconsciously, use their imaginatious, as the desire is always to put in as much detail as possible. When mere fancy assists the optical powers, the resulting drawings are often very pretty and attractive from the number and novelty of the features shown. We can fill in any number of dark belts and bright zones, beaded with spots of various forms and tints, and tone the whole to suit our ideas; but unfortunately such drawings, though pleasing to the eye, have a bad influence, since they pervert the truth, and lack that fidelity to nature which could, alone, make them really valuable.

Mr. Williams, the discoverer of the Saturnian spots, has made some hundreds of observations of them, and fully detailed his methods and his results in the *Monthly Notices* of the R.A.S., liv. p. 297, *et seq.* First detecting them in the spring of 1891, he has now followed them during five oppositions of Saturn. The bright equatorial spots apparently show a period of rotation decreasing with the time, for the mean period during 1891 was 10h. 14m. 22s., while in 1892 it decreased 44 seconds, in 1893 43 seconds, and in 1894 15 seconds. The care with which Mr. Williams proceeded in his work, and the plan he adopted to avoid bias or preconceived ideas, are explained in the paper alluded to, and every one reading his description must be favourably impressed with it. *If his results are fully confirmed*, they will deserve to be ranked among the best observational feats of modern times. To have been the first to discover these delicate objects in all their variety, to have traced out their individual motions with unwearying persistency year by year, and to have employed all the time a very small telescope, must be regarded as a remarkable attainment. It is to be hoped that the necessary corroboration will soon be forthcoming.

I have myself practically endeavoured to afford this, but failed. The spots on Saturn are certainly not visible under powers of 252 and 312 on my 10-inch reflector. The power of 252 is the eye-lens of a Huyghenian eyepiece, that of 312 is one of the "monocentric micrometer oculars" of ¼-inch equivalent focus by Steinheil of Munich. The latter has a distinct advantage over my Huyghenian eyepieces. I have sometimes used a Barlow lens in combination with it, increasing the power to about 450, but do not think any advantage has been gained. I have occasionally had impressions of white spots mottling the bright equatorial zone of Saturn, and occasionally also of faint condensations in the dark belts; but as to seeing these details outright, and obtaining their times of transit with all the certainty of a definite spot on Jupiter, I have quite failed. I am induced to believe, from a number of observations dedicated to

the purpose, that my suspicions of spots were entirely illusory, and that such markings as objective features were invisible to my eye with the means employed. On the worst nights I could easily imagine a mottled aspect of the belts; but with good definition and a steady image, the tone of the belts and bright equator appeared perfectly even and free from noticeable irregularities. In a case of this kind the observer has to be severe with himself. There is a distinct line of demarcation between what is absolutely seen and what is possibly seen or suspected. An object may be only glimpsed, and yet it is certainly seen, for its impressions reach the eye now and then in a form not to be mistaken. But with some objects the experience is different. We fancy they are there, but cannot fix them with certainty; apparently they flit about like an *ignis fatuus*, and are intractable to our utmost efforts. Obviously in such a case the observer has but one alternative, and that is to regard the objects as imaginary.

On Mars, as well as Saturn, small instruments have done wonders. It is well known that the canals and their duplication were discovered by Schiaparelli with a refractor of only 8½ inches aperture. In 1892, during a favourable presentation of Mars, the large American telescopes showed very little either of the canals or of their duplication. During the opposition of 1894 the planet was better placed as regards altitude (but not so near to the earth as in 1892), and the results of observations have been more satisfactory. Mr. Williams with a 6½-inch reflector, and Mr. Brenner with a 7-inch refractor, have recovered many of the double canals of Schiaparelli. Mr. P. Lowell, with the 18-inch refractor at the observatory at Arizona, has also observed many remarkable and intricate details of the planet's topography. This observer remarks that in regard to the visible markings on the inner planets of the solar system up to and including Mars, size of instrument is quite secondary to quality of atmosphere. He draws the "oases" on Mars, and a large number of interlacing lines on the planet, in *Popular Astronomy* for April 1895, and the pictures are very effective. There are many of us who would like to obtain a view of Mars similar to what he has depicted. Mr. Lowell notes that with the 18-inch a power of 420 was as high as the atmosphere permitted to be used with advantage, though drawings were generally made with 370. On the 6-inch refractor 270 showed well, the dark and light markings being more contrasted than in the larger instrument. As affecting the comparative utility of large and small telescopes, Mr. Lowell remarks: "A large instrument is assumed to be necessarily superior to a small one, quite irrespective of what it is that is to be observed. Now the fact is that there are two quite different classes of celestial phenomena—those dependent on quantity of light, and those dependent on quality of definition for their visibility, and the two means to these ends go anything but hand in hand. For the one, the illumination, the size of the instrument is the prime requisite; for the other, the definition, the atmosphere is the first essential. As an object-lesson in this, it is worth noticing that the biggest instruments have not always given the best views of Mars. In matters of Martian detail it is amply evident from the results that observer, atmosphere, instrument, is the order of weight to be given as the factors of an observation."

I have referred to this subject without any desire to take up the cudgels on behalf of any class of instrument, but it is suggestive that the large ones will not bear powers commensurate with their size on planetary details. Thus with the 36-inch at Mount Hamilton a power of 350 has been found the most effective on Mars; a similar power can be used with advantage on glasses of only 8 or 10 inches diameter. It is difficult to understand, therefore, where the superiority of large instruments comes in, as the object is sufficiently bright in small telescopes, and the latter being more easily manipulated and less affected by atmospheric tremors, they obviously possess some distinct advantages. But this interesting and important question is scarcely to be settled by a mere discussion of this sort. It is only to be settled by careful trials of large and small instruments, side by side, upon the planets Mars, Jupiter, and Saturn. If observers having the appliances at command will institute some further comparisons of the kind suggested, the problem might be virtually solved in a short time. Relying upon evidence of fragmentary character is scarcely fair, since differences of eyesight and atmosphere come into play most prominently. The most valuable evidence would be that of an observer who used a number of telescopes of different apertures at one and the same station. Up to the present time it must be confessed that small instruments have somewhat the best of the argument; but if the unanimous testimony of our most trustworthy observers asserted the superiority of large telescopes on bright planets, it is hard to see how they could be disproved, as they alone have the effective means of judging the question on its merits.

W. F. DENNING.

## SUBJECTIVE VISUAL SENSATIONS.[1]

THE activity of the cerebral centres which is independent of their common exciting causes, and which is termed "discharge," presents indications of the character and loss of their function which can be obtained from no other source. Foremost in interest and also in importance are the sensations of sight which occur without stimulation of the retina. Of these the most important are two. (1) Those which occur at the onset of epileptic fits, from the "discharge" in the brain influencing consciousness, through the visual centre, before loss takes place. (2) Those which occur as the precursory symptoms of the paroxysmal headaches which, from their one-sided distribution, have been called "hemicrania," "megraine" or "megrim," from the frequent vomiting, "sick headaches," and, from the inhibitory loss of sight, "blind headaches." These two classes form the subject of the lecture.

In what part of the brain does the process occur? The impulses from the retina reach the cortex of the brain first in the extremity of the occipital lobe, where, as Munk first showed, the half-fields are represented in strictly local definiteness. The left occipital lobe receives the impulses from the left half of each retina, produced by the rays of light from the right half of each field of vision. So, conversely, with the right occipital lobe. To each side, impulses proceed from a very minute area around the central point of the retina, the fixation point of the field. But we cannot conceive that the functional disturbance occurs in these centres, for the strict medial division in two halves is absolutely ignored by the subjective sensations. Moreover, the strange but certain facts of hysterical hemianæsthesia, in which there is inhibition of all the sensory centres of one hemisphere, present us with remarkable evidence of the higher visual function in each hemisphere. This is supported by some cases of organic disease, which cause an affection of sight similar to that of hysteria, and by more common cases of hemianopia from disease of the hemisphere, in which there is a precisely similar contraction of the remaining half-fields. The significance of all these is that the early conclusions of Ferrier are correct, and that, in addition to the lower, occipital half-vision centre, there is a higher centre in each hemisphere, situated in the region of the angular convolution. This theory of the double visual centres, consisting of a combination of the conclusions of Ferrier and Munk, was first stated by the lecturer in 1885, and has been confirmed by all the facts he has since met with. It is indispensable for the comprehension of morbid functional action, and, indeed, for that of normal vision, but is not yet recognised by physiologists, even as hypothetical.

The character of the function of this centre, so far as it can be discerned from the facts of its loss, are of great importance for the study of visual sensations. The two higher centres seem to be blended into one in function in a manner that is unique so far as our knowledge extends. If the centre on one side is functionless, there is loss of sight in the periphery of both visual fields; there is vision in the central third of the eye on the same side, and a far smaller central area on the opposite side. The only conclusion is the startling inference that either higher centre can subserve central vision in both eyes, but that peripheral vision depends on the co-operation of the function of both hemispheres. Between the central area for which either centre suffices and the peripheral area for which neither is competent but both are needed, there is an intermediate zone in which vision is subserved only by the opposite hemisphere when acting alone. This gradation of functional capacity enables some facts of subjective sensations to be comprehended which cannot otherwise be understood.

Moreover, the facts suggest that the function of these higher centres is quite different from that of the lower ones, and from that of other cerebral centres the action of which we can study. In the lower half-vision centres function is localised, so that destruction of part causes absolute loss of a part of the half-field, blindness of the corresponding part of the retina. But partial

[1] The Bowman Lecture, delivered before the Ophthalmological Society, by Dr. W. R. Gowers, F.R.S., June 14.

damage to the higher centre seems to lower the function of the whole, as if the function were diffused, and all its elements were represented, in varying degrees, in every part. This conception is so unfamiliar that it may seem inconceivable, and yet it harmonises with many of the facts of subjective sensations. Moreover, in a large part of the brain, local loss of tissue has only the effect of lowering function as a whole. It seems to be only where the sensory impulses reach the cortex, and motor impulses leave it, that the local distribution of function is definite, and limited damage has definite and lasting results.

The spectra perceived before epileptic fits vary widely. They may be stars or sparks, spherical luminous bodies, or mere flashes of light, white or coloured, still or in movement. Often they are more elaborate, distinct visions of faces, persons, objects, places. They may be combined with sensations from the other special senses, as with hearing and smell. In one case a warning, constant for years, began with thumping in the chest ascending to the head, where it became a beating sound. Then two lights appeared, advancing nearer with a pulsating motion. Suddenly these disappeared and were replaced by the figure of an old woman in a red cloak, always the same, who offered the patient something that had the smell of Tonquin beans, and then he lost consciousness. Such warnings may be called psycho-visual sensations. The psychical element may be very strong, as in one woman whose fits were preceded by a sudden distinct vision of London in ruins, the river Thames emptied to receive the rubbish, and she the only survivor of the inhabitants.

The colours seen are chiefly described as red, green, blue and yellow. A yellowish red-like flame is very common. In some cases red changes to green, a curious complementary relation, when we consider that the sensation is due to a primary process in the centre. One obtrusive fact, in these spectra and in those of migraine, is the frequency with which colours extend to the edge of the field of vision. In one case, each fit was preceded by the appearance of a green colour occupying the lower half of the field so completely that the patient said he seemed to be in a field of grass. It is often said that the periphery of the retina is not sensitive to colour, and that red and green are seen only in the centre. But long ago, Chodin and Landolt showed that colour vision extends to the periphery. The peripheral colour spectra led the lecturer to make a careful examination of the peripheral colour vision, especially in regard to area, to which it seems to be related in a greater degree than to illumination.

Red can be seen up to the margin of the field for white, an area in 6 cm. square; green cannot well be discerned within 5° of the margin, but yellow and blue can be seen up to the margin with 4 cm. square. The fields for each area from ·25 to 4 cm. square are concentric with the field for white.

One fact was ascertained which illustrates the mutual influence of the two visual centres. When both eyes are open the two fields correspond, except in the outer temporal third of each field. The nasal half of left field, for instance, extends to 55° of the outer horizontal radius of the right field, the end of which is at 90°. When both eyes are open, not only is the perception of colour intensified in the part where the two fields overlap, but the intensification goes on to the periphery, through the part in which there is no more retinal stimulation than when the right eye alone is open. Thus, in this radius, red is seen in 2 cm. square at 62° with right eye alone, but at 74° if the left eye is also open, although the left field does not extend beyond 55°. The colour is seen in 4 cm. square at 77° with the right eye only, and at the margin of the field only with 6 cm. square, but with both eyes open the 4 cm. square enables the colour to be seen up to the margin, instead of at 77°. There is thus greater sensitiveness in the centres to colour impulses proceeding from the peripheral region, where the field is single, if light from the other eye intensifies their action—a striking instance of their intimate co-operation.

The motor relations of the epileptic spectrum are instructive but too complex for brief description. It is common, in one-sided fits, for an object to appear at the edge of the field of vision on the side afterwards convulsed, and pass across, to disappear at the opposite side. Its appearance, *e.g.*, on the left is followed by movement of the head towards it, by the motor centres of the right hemisphere, but the head then follows the movement of the spectrum, by the action of the centres of the other hemisphere (sometimes with a conscious sense of irresistible compulsion), and then finally deviates strongly in the first direction, as the convulsion comes on, usually with loss of consciousness. A sense of vertigo may accompany the deviation. The eyes move before the head, and may be absolutely fixed when the head can be moved by the will. These phenomena throw instructive light on the relations of objective and subjective vertigo. Inhibition frequently precedes the epileptic spectra, but is always general, never partial, and neither the loss nor the spectrum is ever on one side only. If they appear on one side, it is only to move across the field, apparently as the result of the effect on the visual discharge of the associated motor nature of the epileptic process.

The visual sensations which precede the paroxysmal headaches of migraine differ very much from the warnings of epilepsy. Their general character is limited, but their forms are extremely varied. One has been well made known by the careful study of his own sensations by Dr. Hubert Airey, published in the *Philosophical Transactions* for 1870, reproduced by Dr. Liveing in his classical work on megrim. (Unpublished drawings by Dr. Airey, and several other series of drawings were exhibited. One curious set was made by a mechanical draughtsman who, from sixty to sixty-five years of age, frequently experienced visual sensations, similar to those of migraine, as isolated symptoms, without headache, and always depicted them as objective things, related to his own figure.) In this class of spectra, inhibitory loss of sight is almost invariable, but it is always partial, never general as in epilepsy, and it bears a definite relation to the spectrum. The phenomena are generally on one side, but occasionally medial, although never central, and they never correspond to one half of the field.[1] Even loss strictly limited to the medial line, as in hemianopia due to organic disease, is practically unknown, contrary to the common impression. The special feature of the "discharge" is an angled line of light, the "zigzag" spectrum, single or repeated, sometimes in many, as it were reflected, fading, lines. In round or oval form it has been termed the "fortification spectrum," from resemblance to the plan of a fortress devised by Vauban. The angled line may be of simple bright light or may present colours, red, green, blue, orange, which sometimes alternate in successive segments. It often seems made up of a multitude of minute brilliant points in rapid movement. When a single bright line, it may be banded on each side by a very narrow black line. This feature may be observed in the "phosphene" produced by pressure on the eye, even in the dark, when it is apparently due to a limiting line of loss of the "essential light of the retina," but its presence in a central spectrum raises the question whether this so-called "light of the retina" is not of purely central origin.

The central region is remarkably indisposed to discharge, but prone to inhibition. A medical practitioner, a careful observer, experienced first a spot of central dimness of sight, which enlarged, becoming darker in the centre and ultimately extended from top to bottom of the field, occupying the middle third, banded on each side by a double curve. Sometimes, when the spot had reached half-way to the top and bottom of the field, a bright zigzag line appeared on one side, which extended upwards and downwards, as the inhibitory loss increased, became brighter, but seemed to restrain the inhibition, which extended no further on that side, but was, as it were, reflected back and reached almost the extreme edge of the field on the other side. This illustrates the occurrence of the discharge secondary to inhibition, and limiting it. It is an instance of the way in which all half-field relations are absent in these phenomena. The common commencement is for an angled sphere, or stellate spectrum, to appear in the middle zone of one half of the field, and, expanding, form an oval within which vision is partially or completely lost. The edge is often coloured. The angles are especially developed towards the outer side of the field. Towards the centre of the field the expansion is less, the angles smaller, and the spectrum breaks. Sometimes one limb passes downwards, and the other towards the central point, but in the latter the angles gradually cease, and the spectrum never reaches the centre—an illustration of the resistance of the central region to discharge. In other cases, however, the ends of the broken oval may pass into the other half of the field, one on each side of the central point, enclosing this between them. When they reach the middle zone on the other side, a second star, like that from which the spectrum originated, may suddenly appear for a short time as a terminal feature. These characteristics show how remarkable must be the relation of the centres in which their cause occurs.

[1] By "field" is meant the area included by the boundary of the conjoined fields of both eyes, to which alone the central phenomena seem related.

An angled spectrum of curved course may also develop by progression through the middle zone, beginning below, and attaining its chief development in the upper half of that side, passing only a little way beyond the middle line above. In one case this was preceded by a transient angled star near the point of commencement, and its early stage was accompanied by inhibitory loss at the margin of the field, outside the region in which the discharge commenced.

Although discharge never occurs at the central point, it may occur around it, as a circular zigzag, surrounding a round object looked at—an instructive example of the fact that the discharge may be related to the central effect of actual retinal stimulation. Analogous to this "pericentral" spectrum, is one that takes the form of an arch above the central region, which may separate into two parts at the middle line. As an instance of the strong tendency there is to regard the spectrum as an objective thing, a member of the medical profession, when asked to draw that which he saw, sent a drawing of his eye surmounted by an angled corona. These forms again indicate disturbance in centres in which there is no half-field representation. Besides other forms, an angled spectrum sometimes appears near the outer temporal edge of the field, and extends outwards for a short distance and then curves downwards, never upwards. Such a peripheral spectrum always seems to the subject to begin at the extreme edge of the field and extend outside it. In one case it was drawn as attached to the junction of the upper and lower eyelids.

It cannot be doubted that, by the study of these subjective symptoms, much will ultimately be learned regarding the function and mode of action of the cerebral visual centres. Whatever the drawbacks to observation through the consciousness of another person, knowledge can be gained in no other way of the action of the higher centres of the brain, and the time must come when the physiological knowledge which can be gained only through the effects of disease and the disturbance of functional derangement, will receive more attention. The facts of these spectra, when studied in their detail, compel the conclusion that they occur in centres in which function is related to the conjoint fields, and in these to a central and a peripheral region and to a medial zone between the two; that the chief relations are central and peripheral; that outside the central region there is a one-sided relation, but that there is no distribution of function at all corresponding to the division of the fields at the medial line. The dominant relation is concentric, and the indications afforded by the absolute one-sided loss caused by destruction of one occipital lobe, has no reflection, positive or negative, in these results of spontaneous central activity.

## *HIGH-LEVEL METEOROLOGICAL STATIONS.*[1]

ONE of the greatest drawbacks to a full understanding of meteorological phenomena is that the observations on which we base our knowledge are generally made close to the ground in the most restricted air-stratum; whereas the general atmospheric movements, both in velocity and direction, are much modified in the lower strata, and the air surrounding and in contact with the earth differs greatly both in temperature and humidity from the free air. The more strongly agitated upper strata react on the lower in many ways, and a knowledge of the movement of the moderately high atmospheric layers is of great importance for the theory of the general circulation of the atmosphere, and practically for our weather forecasts, since the forces which develop storms have their origin and sphere of action within two or three miles of the earth.

If the atmosphere were only in complete equilibrium, then the few irregular observations, as regards time and place, which have been made in balloons, would give some data on which to base general laws; but, in the actual condition of continual movements and changes in the atmosphere, this can never suffice, and the continuous observations required of all the elements, at all seasons and in all weathers, can only be made on mountains, even though the conditions there only approximate to those of the free air. In this way observations on mountains complete those of the usual low-level stations.

When the earth's surface rises in plateaux, the advantage of elevation above the sea—that is to say, the immersion in the upper strata—is almost entirely neutralised, because still our instruments are placed in air masses which are affected by contact with the earth. For this reason meteorological observatories should be located on high and isolated peaks. The erection of such stations and the discussion of their observations during the last fifteen years have contributed largely to the rapid progress of the science of meteorology.

The chief first order stations (those possessing self-recording instruments, or where observations are made on an extensive scale) which are located on mountain tops in the various countries, will now be briefly described.

The first summit station in the world was that established in 1870, jointly by the U.S. Signal Service and Prof. J. H. Huntington, on Mount Washington, N.H., 6280 ft. above the sea. Probably nowhere else in the world has such severe weather been experienced, the lowest temperature being here often accompanied by the highest winds, unlike the calms which prevail with intense cold at low levels. For instance, in February 1886, with a temperature of 50 degrees below zero, a wind velocity of 184 miles an hour was recorded on Mount Washington. The Government meteorological station on Pike's Peak, at an elevation of 14,134 ft., was for many years the highest in the world. Now both these stations are closed, so that there seem to be actually in the United States but two summit stations where meteorological observations are made throughout the year, viz.: The Lick Observatory, on Mount Hamilton, California—primarily astronomical—and the Blue Hill Meteorological Observatory in Massachusetts, situated at a very moderate elevation. Prof. S. P. Langley's important researches on the nature and amount of solar heat received by the earth were carried on in 1881 upon Mount Whitney, the summit of which is 14,500 ft. above the sea.

It is due to an American institution that the highest meteorological station in the world is now in Peru, where the Harvard College Observatory, several years ago, established an outpost at Arequipa. In 1893, Prof. Bailey succeeded in placing self-recording instruments on the summit of the neighbouring volcano of El Misti, 19,300 ft. high, when a former station on the side of Mount Chachani, near the snow-line, at an elevation of 16,650 feet, was abandoned. It is impossible for persons to remain at these stations, so they were provided with automatic instruments which should give a continuous record of the chief meteorological elements during two weeks. Several times a month one of the Observatory staff climbs the mountain in order to wind the clocks and change the register sheets, at the same time making a check reading of standard instruments. Breaks in the record occur, owing to unforeseen stoppage of the instruments, or inability to make the ascent at the appointed time.

France stands unrivalled in her superb chain of summit stations on the Puy de Dôme (4800 ft.) in Auvergne, on the Pic du Midi (9440 ft.) in the Pyrenees, on the Mont Ventoux (6250 ft.) in Provence, and on the Aigoual (5150 ft.) in the Cevennes, whose construction has cost the national and provincial Governments hundreds of thousands of dollars and years of time. They are generally defective in having no co-operating base stations, and their observations have not been published in detail. In 1890, M. Vallot, a devoted Alpinist and meteorologist, established several stations on and near Mont Blanc, from which records have been obtained each summer since. The highest of these stations, at the Rochers des Bosses, 14,320 ft., is provided with many self-recording instruments operating two weeks without attention, which are looked after by the owner or his guides each week or two during the summer. The Observatory of M. Janssen, sunk in the snow on the very top of Mount Blanc, 1460 ft. higher, is not yet in operation, but a meteorograph has been made for it in Paris, which will continuously record all the meteorological elements during a period of three months without attention. A similar instrument is being constructed at Blue Hill, by Mr. Fergusson, for Prof. Pickering's station on El Misti.

On the Eiffel Tower in Paris are instruments 980 ft. above the ground, which give more nearly the conditions prevailing in the free air than do any others permanently at this elevation. They record at the Central Meteorological Office, a quarter of a mile distant, side by side with similar instruments exposed near the ground.

Among the German and Austrian stations, that on the Sonnblick, a peak of the Austrian Alps, 10,170 ft. high, and the highest permanently occupied observatory in Europe, stands pre-eminent, having furnished very valuable results under Dr. Hann's direction.

[1] Extracted from a paper, by Mr. A. Lawrence Rotch, read before the Boston Scientific Society.

Switzerland, which since 1873 had maintained stations in mountain passes, &c., has now on the Säntis (8200 ft.) in the canton of Appenzell, one of the best located and equipped summit stations in the world; and in Italy an observatory on Monte Cimone (7100 ft.) in the Apennines, near Lucca, has recently been completed.

On Ben Nevis, the highest mountain in Great Britain (4400 ft.), there is a remarkable station where during ten years an unbroken series of hourly observations has been maintained. There is a base station at sea-level, and the advantageous situation on the west coast of Scotland renders the results of the observations, which have been discussed by Dr. Buchan, of great value.

It is impossible to even enumerate all that has been gained from these high-level observations, but the chief results attained, or still sought, may be thus summarised: Determination of normal decrease of temperature and humidity with elevation; abnormal changes with elevation in cyclones (or areas of low pressure near the ground) and in anti-cyclones (or areas of high pressure near the ground); height to which these cyclones and anti-cyclones persist, and the circulation of the air around each at various levels.

## *UNIVERSITY AND EDUCATIONAL INTELLIGENCE.*

OXFORD.—At the Encaenia, or Commemoration of Oxford Founders, held on June 26, the honorary degree of D.C.L. was conferred upon Sir W. H. Flower, Prof. Michael Foster, M. Edward Naville, the distinguished Swiss Egyptologist, and Sir A. W. Franks, President of the Society of Antiquaries.

SIR J. E. GORST has succeeded Mr. Acland as Vice-President of the Council for Education.

MR. HERBERT HANCOCK, Mathematical and Physics master in Bancroft's School, Woodford, London, has just been appointed to the headmastership of the Hipperholme Grammar School, an important science centre for the North of England.

AT a Convocation of Durham University on Tuesday, June 25, the Sub-Warden announced that the new Charter had been received by which power is given to the University to confer degrees upon women in all faculties except Divinity. Among a large number of degrees conferred was that of Bachelor of Science on Miss Ella Mary Bryant, Durham College of Science, Newcastle.

IN consequence of the shortly ensuing General Election, the annual meeting of the National Association for the Promotion of Technical and Secondary Education, and the Conference of representatives of Technical Education Committees, which had been arranged to take place in London on July 11, have been postponed.

ON Thursday last a very successful and numerously attended conversazione was held at University College, London. The guests were received on the grand staircase by the President (Sir John Erichsen, Bart., F.R.S.) and Deans of Faculties. The various scientific departments of the College were thrown open, and many interesting exhibits contributed to the success of the evening. Among the latter were included the spectra of argon and helium, various electrical and physical experiments, living seaweeds and marine animals, new models of dividing nuclei, &c.

THE University of London has conferred the degree of Doctor of Science, without examination, on Mr. Th. Groome, Professor of Natural History at the Royal Agricultural College, Cirencester, in recognition of the merits of his original researches and published papers.

THE Berlin correspondent of the *Lancet* writes as follows:—"The publication of a rumour that the authorities intend to abolish the University of Jena, has caused a stir in the scientific world, the university being one of the oldest in Germany, and having often occupied a leading position. Financial reasons are said to have induced the authorities to arrive at this decision. The constitution of the University of Jena is somewhat peculiar. It is not under the jurisdiction of a single State, but belongs jointly to four States of Thuringia, viz., Saxe-Weimar, Meiningen, Coburg, and Altenburg. The Governments of those small States entirely control the affairs of the university. If, for instance, a new professor is to be appointed they must all consent to his nomination. To put a stop to the further propagation of this rumour, the official journals of the four united Governments declare that the continued existence of this venerable university is assured both by public grants and by large donations recently made by old pupils and others. This communication has been received with general satisfaction, particularly in the town of Jena itself, which is entirely dependent upon the university."

## *SCIENTIFIC SERIALS.*

*The Mathematical Gazette*, No. 5 (May 1895).—This number opens with a paper read by Dr. C. Taylor at the annual meeting of the A.I.G.T. in January last, of which the title is "The Syllabus of Geometrical Conics." In it the writer passes in review what he has done in the subject since his first contribution to the *Messenger* in 1862. Amongst other reasons for writing at this date, Dr. Taylor states: "I have, as I think, arrived at something like finality in my own view of the way in which the subject should be approached." It is on this ground that we commend the author's paper to persons interested in the teaching of geometrical conics. They will derive profit from it. The second of the mathematical worthies noticed by Mr. Heppel is John Dee, noteworthy from his contributions to Billingsley's translation of Euclid. The notes, solutions of *Gazette* questions, solutions of examination questions, and questions for solution, which are all very useful for the readers addressed, are, with the enlarged form of the journal, greatly increased in number and variety. Several recent text-books are also the subject of judicious and discriminating criticism. The *Gazette* should certainly have a successful career.

*American Journal of Mathematics*, vol. xvii. No. 3.—On irrational covariants of certain binary forms, by E. Study, discusses the most important covariants of binary cubics and quartics and of some other special binary forms. After paying tribute to the methods of Cayley and Clebsch, the author gives his reasons for working the whole subject over again. By means of a carefully chosen system of notation, he presents his results, as he believes, in a form that will be useful to those who have to deal with the numerous applications of the binary quantics of the lowest orders. In some detail (pp. 185–215) he examines the cubic, and the quartic and octahedron, and points out several small numerical errors in previously obtained results. The same writer contributes an article on the connection between binary quartics and elliptic functions. This is an application of the theory developed in the previous article to elliptic functions. In it he compares the relations among the rational and irrational covariants of a quartic with the identities among the four theta-functions; by this means a new light is thrown upon the familiar formulæ, and at the same time a number of new results are derived, which make the theory in question, the author states, in a certain sense *complete*. Stress is laid upon the fact that all the results are obtained by means of *actual calculations*, and that no use is made of the method of indeterminate coefficients.—Semi-combinants as concomitants of affiliants, by H. S. White, opens up a new path apparently (pp. 234–265): "I consider all ground forms that are included in the conjunctive of the system, and those of them that satisfy invariant equations of suitable order, linear in their coefficients, I designate as *affiliant* ground forms." The paper shows that not only is every semi-combinant ground form an affiliant, but also every affiliant ground form is a semi-combinant. Three short notes follow, viz.: Simplification of Gauss's third proof that every algebraic equation has a root, by M. Böcher, a note read before the American Mathematical Society (*cf.* NATURE, p. 189); note sur les lignes cycloïdales, by R. de Saussure; and note on lines of curvature, by T. H. Taliaferro.

## *SOCIETIES AND ACADEMIES.*

### LONDON.

**Royal Society**, April 25.—"*Acokanthera Schimperi*: Natural History, Chemistry, and Pharmacology." By Prof. Thomas R. Fraser, F.R.S., and Dr. Joseph Tillie.

Specimens of the wood from which the Wa Nyika, Wa Gyriama and Wa Nyika arrow-poison is prepared have been examined by us and referred to the genus *Acokanthera*, and

leaves, flowers, and fruit, each taken from the same individual tree, having also been sent to us, we have been enabled to determine that the wood of the species *Acokanthera Schimperi*, Benth. and Hook. (*Carissa Schimperi*, A.DC.), is used by the Wa Nyika and other tribes inhabiting the coast regions near Mombasa in preparing their arrow-poisons.

The arrow-poisons of these tribes usually contains a crystalline glucosidal active principle, which, in its chemical properties and pharmacological action, is identical with the active principle also separated by us from the wood of *Acokanthera Schimperi*.

The complete recognition of the species of *Acokanthera* is of primary importance, because several supplies of the wood of unidentified species of *Acokanthera* sent to us from East Equatorial Africa yielded only a glucosidal active principle which was amorphous.

The characters of the crystalline active principle which we have separated from the wood of the fully identified species, *Acokanthera Schimperi*, Benth. and Hook., agree with those of the crystalline active principle ouabaïn, separated by Arnaud from the wood of the unidentified species of *Acokanthera*, provisionally named *Ouabaïo*, obtained from North Somaliland, and also from the seeds of an unidentified species of *Strophanthus*, obtained from West Africa. As, however, the name ouabaïn is used for three quite different substances, two of which are amorphous, we would suggest that, in accordance with a usual custom, the crystalline active principle of *Acokanthera Schimperi* should be named acokantherin, and not ouabaïn.

The work accomplished by Arnott and by Haines in 1853, by Ringer in 1880, by Rochebraune and Arnaud in 1881, by Laborde in 1887, by Langlois and Varigny, by Gley and Rondeau, and by Gley in 1888, by Sailer in 1891, by Paschkis in 1892, and by Lewin in 1893, has been more fully described in this paper than in our preliminary notice of March 23, 1893.

A detailed examination of the pharmacological action of acokantherin has not led to the discovery of any important qualitative differences between its action and that of *Strophanthus hispidus* and of its active principle strophanthin, which was described by one of us in 1870, in 1872, and in 1890. As, however, a special interest must be attached to the effects upon the circulation, the experiments upon the heart, blood-vessels, and blood-pressure are described with more detail than those upon other systems.

The predominant action of acokantherin is that exerted upon striped muscle, and, because of this action, with possibly an action upon the intrinsic cardio-motor ganglia, the chief effect is produced upon the heart, while the influence exerted upon the cardio-respiratory centres in the medulla is relatively slight or secondary.

May 30.—"On the Effect of Pressure of the Surrounding Gas on the Temperature of the Crater of an Electric Arc Light. Preliminary Notes of Observations made at Daramona, Streete, Co. Westmeath." By W. E. Wilson.

Of late years it has often been assumed that the temperature of the crater forming the positive pole of the electric arc is that of the boiling of carbon. The most modern determinations give this point as about 3300°–3500° C.

Solar physicists have thought that the photosphere of the sun consists of a layer of clouds formed of particles of solid carbon. As the temperature of these clouds is certainly not below 8000° C., it seems very difficult to explain how carbon can be boiling in the arc at 3500° and yet remain in the solid form in the sun at 8000°. Pressure in the solar atmosphere seemed to be the most likely cause of this, and yet, from other physical reasons, this seemed not probable.

In order to investigate whether increased pressure in the gas surrounding an electric arc would raise the temperature of the crater, the author used a strong cast-iron box in the interior of which an electric arc light could be maintained. At the side of the box was inserted a glass lens, by which an image of the crater was formed at a distance of 80 cm. When this image was allowed to fall on the aperture of a Boys radio-micrometer, the deflections of this instrument showed any variations in the radiation from the crater. The author then describes the experiments made with this apparatus, and shows that by increasing the pressure of the gas in the box the temperature of the crater is considerably lowered intead of being raised, and he concludes that these experiments seem to show that the temperature of the crater, like that of a filament in an incandescent lamp, depends on how much it is cooled by the surrounding atmosphere, and not on its being the temperature at which the vapour of carbon has the same pressure as the surrounding atmosphere. That carbon volatilises in some form at comparatively low temperatures seems likely, from the way in which the carbon of incandescent lamp filaments is transferred to the glass. The pressure of the vapour of carbon in the arc may consequently be very small, and further it would seem that the supposition of high pressures in the solar photosphere, which has been referred to in the beginning of this paper, is not borne out by these experiments, and that carbon may exist there in the solid form at very high temperatures although the pressures are comparatively low.

June 13.—"Further Observations on the Organisation of the Fossil Plants of the Coal Measures. Part 3. *Lyginodendron* and *Heterangium*." By W. C. Williamson, F.R.S., and D. H. Scott, F.R.S.

The authors sum up their conclusions as follows:—

The vegetative organs of these genera show a remarkable combination of fern-like and cycadean characters. The leaves of *Lyginodendron*, which are now well known, are so like fern-leaves, not only in form and venation but in minute structure, that if they stood alone they would, without hesitation, be referred to Filices. Although many leaves simulate those of ferns in external characters (*Stangeria*, *Thalictrum*, &c.), none are known which at the same time show the characteristic anatomy of fern-leaves. Hence we are led to attach great weight to the characters of the *Lyginodendron* foliage. That of *Heterangium*, though less well preserved, was evidently of the same type.

In *Heterangium* the primary structure of the stem is much like that of a monostelic fern such as *Gleichenia*, but the leaf-trace bundles closely resemble the foliar bundles of a Cycad.

In *Lyginodendron* the whole structure of the *stem* suggests a Cycad, but with the remarkable peculiarity that the bundles here have the structure which in Cycadeæ is usually (though not always) limited to those of the leaf. The cycadean characters are too marked to be accidental, though the general anatomy of *Lyginodendron* is not inconsistent with a close relationship to ferns, for in *Osmunda* we have a monostelic fern, with a large pith, collateral bundles in the stem, and concentric ones in the leaf. The mere occurrence of secondary growth in a fern-like plant is not surprising, considering that it takes place in *Botrychium* and *Helminthostachys* at the present day.

In various respects *Lyginodendron* and *Heterangium* have points in common with Gleicheniaceæ, Osmundaceæ, Marattiaceæ, Ophioglosseæ, and Cycadeæ. The view of their affinities, which we suggest, is that they are derivatives of an ancient generalised race of ferns, from which they have already diverged considerably in the cycadean direction. Of the two genera, *Heterangium* appears to be geologically the more ancient, and certainly stands nearer to the filicinean stock. *Lyginodendron*, while retaining conspicuous fern-like characters, has advanced much further on cycadean lines. This view by no means involves the improbable assumption that these plants were the actual ancestors of existing Cycadeæ. How far their divergence from the fern stock had proceeded cannot be determined until we are acquainted with their organs of reproduction.

The existence of a fossil group on the border land of ferns and Cycads seems now to be well established. Count Solms-Laubach places his *Protopitys* in this position, which is probably shared by *Myeloxylon* and *Poroxylon*. Messrs. Bertrand and Renault have indeed endeavoured to derive the last-named genus from Lycopodiaceæ, and have extended the same view to *Lyginodendron* and *Heterangium*. In the latter cases their theory is completely negatived by the organisation of the leaves, and by many structural details.

The relation of the genera which we have described to those ancient gymnosperms, the *Cordaiteæ*, will form one of the most interesting palæobotanical problems of the future.

The paper is illustrated by micro-photographs and by camera-lucida drawings.

**Geological Society**, June 19.—Dr. Henry Woodward, F.R.S., President, in the chair.—On the occurrence of radiolaria in chalk, by W. Hill and A. J. Jukes-Browne. The authors noticed the rarity of records of Cretaceous radiolaria, and alluded to those which have been made, including those by Rüst and Sollas. They recently discovered spherical bodies resembling in form and general appearance certain calcified and partially destroyed radiolarian tests from some of the Barbadian

rocks; microscopic examination of these proved that many of them, at any rate, are radiolaria. The bodies occur in the nodules of the lower beds of the Melbourn rock at Melbourn, Royston, near Hitchin, Leagrave, near Luton, Pitstone and Tring, Watlington, the Richmond boring, the lower part of the "Grit Bed" at Dover, Sutton Waldron and Burcombe (Dorset), and in a nodular chalk which may be considered as the equivalent of the Melbourn rock from Bindon Cliffs, near Axmouth, Devon. Similar organisms have recently been found in the chalk marl of Lincolnshire, Yorkshire, and Norfolk, but have not been noticed in any other parts of the chalk. It was suggested that they occurred in many portions of the chalk-ooze, but were usually rapidly and completely dissolved, and contributed to that solution of silica which furnished the substance of flint-nodules; and the authors concluded that the preservation of traces of the radiolaria in the nodules of the Melbourn rock was due to some specially favourable conditions. A description of the changes undergone by Barbadian radiolaria was given to illustrate the instability of radiolarian tests. All stages were traceable, from the perfect siliceous test to a structureless ball or disc filled with calcareous matter, or a mere patch of clear crystalline material. A description of forms recognised in the nodules of the Melbourn rock was given.—The crush-conglomerates of the Isle of Man, by G. W. Lamplugh, with an appendix by W. W. Watts. The Skiddaw slates of the Isle of Man have everywhere undergone intense shearing, and on the north-west side of the main stratigraphical axis actual disruption of the bedding with the resultant formation of breccia or crush-conglomerate on a large scale has taken place. This structure attains its widest development on the north side of the central valley, though it is noted on a more limited scale in a few localities farther south. The sections described showed the gradual smashing into fragments of highly contorted strata until every trace of the original bedding is lost, and a "crush-conglomerate" with lenticular and partly rounded inclusions is formed. The rocks described in Mr. Watts's appendix were grouped in four classes. Firstly, the grits and slates which had been crushed but had not been converted into crush-conglomerates; secondly, the crush-conglomerates themselves, and the fragments which they contain; thirdly, the dykes of decomposed dolerite (greenstone) and fresh later dolerite which penetrate the conglomerate; fourthly, a portion of the crush-conglomerate metamorphosed by these intrusions. The chief point of interest was brought out by the examination of the fragments in the conglomerate. All stages of crushing could be traced, until the grit-fragments had a structure which was a mere miniature of the crush-conglomerate itself; that is to say, if the crush-conglomerate be regarded as made of "fragments" of hard rocks enclosed in crushed "matrix" of soft rocks, a host of intermediate varieties with varying resistances will occur.—The chalky clay of the Fenland and its borders; its constitution, origin, distribution, and age, by Sir Henry H. Howorth, M.P., F.R.S. The distribution of the clay (so often termed chalky *boulder* clay) was noticed. The paucity of foreign stones was noted as compared with natives, and the similarity of the matrix of the chalky clay to the material of the older deposits of the neighbourhood. The author maintained that the contents of the clay indicate movement of material from west to east in some places, as shown by Jurassic fossils in the East Anglian chalky clay, and from east to west in others; in fact, that movement took place in sporadic lines diverging from the Wash and the Fens. He appealed to the amount of disintegration that had taken place to furnish the material for the clay, the shape of the stones in the clay, and the distribution of the clay itself, as evidence against the action of land-ice or icebergs, and maintained that there was no evidence of submergence at the time the clay was formed; and criticised the attempts made to explain the formation of the clay by water produced by the melting of ice.—On the occurrence of *Spirorbis*-limestone and thin coals in the so-called Permian rocks of Wyre Forest; with considerations as to the systematic position of the "Permians" of Salopian type, by T. Crosbee Cantrill. In South Staffordshire a thick series of red rocks—the so-called Lower Permian—overlies the ordinary yellow and grey coal measures, and underlies the Triassic rocks. They consist of sandstones, marls, calcareous conglomerates, and breccias, having a general red or purplish-red colour. Sinkings have shown that these red rocks must be regarded as of Upper Coal Measure age, because their included fossils have an Upper Coal Measure *facies*. The rocks contain bands of limestone characterised by the presence of *Spirorbis pusillus*: those parts of the series which have not yielded Coal Measure fossils being apparently similar lithologically to those which have yielded them. The evidence furnished by the deposits of the Forest of Wyre (=Enville) district also led the author to regard the red rocks associated with *Spirorbis*-limestone and coals as Upper Coal Measures, exhibiting a gradual passing away of Coal Measure conditions and the incoming of those of new red sandstone times.

**Linnean Society**, June 20.—Mr. C. B. Clarke, President, in the chair.—Mr. F. Enock exhibited and made some remarks upon a living specimen of an aquatic hymenopterous insect, *Polynema natans*, Lubbock.—Messrs. E. Baker and C. Reid exhibited some rare plants from the limestone hills, Co. Kerry, including *Pinguicula grandiflora*, Lam. contrasted with *P. vulgaris*, and *Saxifraga Geum* contrasted with *S. umbrosa*, with a view of determining their value as sub-species or geographical races.—Mr. Carruthers exhibited some feathers of a cuckoo taken at Whitchurch, Shropshire, on May 23 last, amongst which were some moulted feathers which were held connected with the new feathers which had replaced them by means of the barbed seed capsules of a sub-tropical grass, *Cenchrus echinatus*.—On behalf of Mr. S. Loat, there was exhibited a cuckoo's egg, taken from the nest of a hedge-sparrow, together with five white eggs of that species, an abnormality not often met with. An examination of these eggs under the microscope showed that, in regard to the texture or grain of the shell, they agreed with eggs of the hedge-sparrow, and not with those of the robin, of which white varieties are not so rare.—Mr. George West then gave the substance of a paper on some North American *Desmidieæ*, describing the characters of several new species with the aid of specially prepared lantern slides.—Mr. A. Vaughan Jennings gave a detailed account of the structure of the Isopod genus *Ourozeuktes*, upon which a most instructive criticism was offered by the Rev. J. R. Stebbing, who was present as a visitor; some further remarks being offered by Mr. W. P. Sladen.—Mr. F. N. Williams communicated the salient points in a critical paper which he had prepared, entitled "A Revision of the Genus *Silene*."—On behalf of Mr. E. R. Waite, Prof. Howes gave an abstract of a well illustrated paper on "The Egg-cases of Port Jackson Sharks," and exhibited several spirit specimens in further elucidation of the subject.—This meeting terminated the session.

PARIS.

**Academy of Sciences**, June 24.—M. Marey in the chair.—On the gradual extinction of an ocean-roller at great distances from its place of production: formation of equations of the problem, by M. J. Boussinesq.—New studies on the fluorescence of argon and on its combination with the elements of benzene, by M. Berthelot. With the help of M. Deslandres, the author has made a more complete spectroscopic examination of the emerald-green light produced by the fluorescence of argon under the influence of the silent electric discharge. The significance of the various rays observed or photographed is discussed. Finally, the conclusion is drawn that this fluorescence is definitely due to a condensation compound of argon; it points to the probable existence of a complex state of equilibrium in which argon, mercury, and the elements of benzene are concerned.—On the campholenic lactones, by MM. Berthelot and Rivals. The lactones have heats of formation greater than those of the isomeric acids.—On the heats of solution and neutralisation of campholenic acids, by M. Berthelot.—Reduction of silica by carbon, by M. Henri Moissan. With a current of 1000 amperes at 50 volts, the author has obtained characteristic crystals of silicon, but always mixed with carbon silicide. At the high temperature attained, carbon from the crucible reduces the silica of the charge.—Observations on a note, by MM. Barbier and Bouveault, on the products of condensation of valeric aldehyde, by M. C. Friedel.—On the integration of linear equations by the aid of definite integrals, by M. Ludwig Schlesinger.—On the determination of the ratio of the two specific heats for air, by M. G. Maneuvrier. A new method and new apparatus are described. The experimental determination of the ratio of the specific heats has yielded the following numbers:—Air, $\gamma = 1 \cdot 3924$; carbon dioxide, $\gamma = 1 \cdot 298$; hydrogen, $\gamma = 1 \cdot 384$ under the ordinary conditions of temperature and pressure.—On the propagation of sound in a cylindrical tube, by MM. J. Violle and Th. Vautier. An account of the conduction of musical sounds over long distances by pipes of wide diameter.—On the refraction and dispersion of ultra-violet radiations in some crystallised substances,

by M. G. Adolphe Borel.—On the variations of "écrouissage" of metals, by M. Faurie.—On punching, by M. Ch. Fremont. An experimental inquiry into the conditions affecting the amount of play necessary between a punch and its bed. The results lead to the conclusions: (1) That the maximum effort in punching metals is independent of the clearance space in the ordinary practical conditions; (2) that the clearance space or play is a function of the thickness of the metal to be punched, and not of the diameter of the punch; (3) that it is also a function of the elongation of the metal, but in a less proportion; (4) that the play allowed ought to be about a fifth of the thickness of the metal punched. A figure is given illustrating the form of punch best adapted for piercing perfect holes.—Properties of solid carbonic acid, by MM. P. Villard and R. Jarry. Carbon dioxide solidifies and melts under a pressure of 5·1 atmospheres at $-56°\cdot7$ C. In free air, the solid has the temperature $-79°$; ether does not lower this temperature, as has been hitherto supposed, but methyl chloride and solid carbon dioxide produce a temperature of $-85°$ C. At a pressure of 5 mm. the solid has reached a temperature of $-125°$.—On M. Guye's hypothesis, by M. A. Colson.—On the alcohols derived from a dextro-rotatory turpentine, eucalyptene, by MM. G. Bouchardat and Tardy.—Condensation of the unsaturated alcohols of the fatty series with dimethylketone.—Synthesis of aromatic hydrocarbons, by MM. Ph. Barbier and L. Bouveault.—Double compounds of the fatty and aromatic nitriles with aluminium chloride, by M. G. Perrier.—Action of the air on raisin must, by M. V. Martinand.—On the preservation of wheat, by M. Balland.—On the sexual dimorphism of the Nautilus, by M. A. Vayssière.—On the variations of apparent clearness with the distance, and on a law of these variations as a function of the luminous intensity, by M. Charles Henry.—Seismic observations made at Grenoble, by M. Kilian.—On the dissolved gases at the bottom of Lake Geneva, by MM. André Delebecque and Alexander Le Royer.—The effects of the synodic and anomalistic revolutions of the moon upon the distribution of pressures in the season of winter, by M. A. Poincaré.—On the subject of the treatment of the bites of venomous serpents by chloride of lime and by antitoxic serum, by M. A. Calmette.

AMSTERDAM.

**Royal Academy of Sciences**, May 25.—Prof. Van de Sande-Bakhuyzen in the chair.—Prof. J. C. Kapteyn showed how the following three laws may be deduced from observations: (1) the law according to which the linear velocities of the stars are distributed; (2) the law according to which the number of stars per unit of volume varies with the distance from the sun; (3) the law according to which the absolute stellar magnitudes (magnitude at unit of distance) are distributed. The hypotheses on which the author's conclusions were based were as follows: (*a*) the real movements of every degree of magnitude of the stars in space are equally numerous in every direction; (*b*) the law of the distribution of stellar velocities does not vary with the distance from the sun; (*c*) the function representing this law has but a single maximum.—Prof. Engelmann treated of reciprocal and irreciprocal conductivity of muscles, with special relation to the theory of the heart.—Prof. Van der Waals treated of the relation between the critical temperature and the critical pressure for a mixture (tacnodal curve).—Prof. H. Behrens described some cases of artificial dichroism. Strong dichroism were observed on flax and hemp fibres after having been dyed with congo-red or benzo-azurine. A similar result was obtained with the majority of the tetrazo-dyestuffs used for dying cotton; whereas, by the application of naphthol orange, croceine scarlet, and other similar dyestuffs, no dichroism was developed. Only three basic dyestuffs were found to be capable of making flax dichroic. Among other fibres the straw fibre comes next to flax and hemp; the cotton and the wood fibres stand lower in the scale; silk requires to be dyed a deep blue with an acidulated solution of benzo-azurine, and on wool the phenomenon of artificial dichroism has not been produced by any of the colouring matters named above. Flax and hemp are strongly polarising, and can be rendered strongly dichroic, while in cotton these two qualities are found in a smaller degree; but silk, ranging above straw in polarisation, falls far below cotton as to artificial dichroism. The phenomenon seems to be of a complex nature, not explained by assuming a combination of ordinary absorption with ordinary double refraction.—Prof. Van der Waals presented a paper by Prof. W. H. Julius, entitled "On an arrangement for protecting measuring instruments from the ordinary vibrations of the ground."—Prof. Kamerlingh Onnes presented, (1) on behalf of Prof. W. Einthoven, an isolation arrangement against vibrations of contiguous bodies; (2) on behalf of Dr. J. P. Kuenen, the influence of gravitation upon the critical phenomena of simple substances and mixtures.

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